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COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
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NATURAL LAND DIVISIONS OF SANTA CRUZ COUNTY, CALIFORNIA: THEIR UTILIZATION AND ADAPTATION

R. EARL STORIE

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R. EARL STORIE[2]

INTRODUCTION

BEFORE AN adequate picture of the best land use of any area can be secured, there must be available certain basic information regarding the physical conditions such as soil, topography, elevation, drainage, and climate. A classification of the physical land features and a correlation of these features with the present utilization of the land and its productivity give fundamental information on which any program of future land use can be based.

A study of this kind has been made in Santa Cruz County, and in this publication are presented: (1) a system of physical land classification; (2) the present use of the land; (3) the correlation between these physical conditions and uses; (4) the productivity for various crops, for grazing, and timber; (5) the correlation between crop productivity and the character of the soil as expressed by the Storie soil-index ratings; and (6) some of the adaptations and land problems involved.

Various state and governmental agencies have made available valuable data for this work. In 1935 the California Agricultural Experiment Station, coöperating with the United States Department of Agriculture Bureau of Chemistry and Soils, made a detailed soil survey of the county.[3] The soil classification of this soil survey has been used as a basis, or starting point, in setting up the natural land divisions discussed in this paper. A crop map was compiled in 1935 and 1936 by the California Agricultural Experiment Station. Three other divisions of the United States Department of Agriculture contributed valuable factual data: the California Forest and Range Experiment Station completed a cover-type survey of the county. About 1936 the Land Utilization Division of the Bureau of Agricultural Economics completed a map showing the present use of land in Santa Cruz County. In 1934 the Soil Conservation Service set up a demonstration project in the vicinity of Corralitos, Aptos, and Watsonville, and from its studies certain information was obtained regarding land use and erosion.

[1] Received for publication March 15, 1939.

[2] Lecturer in Soil Technology and Associate Soil Technologist in the Experiment Station.

[3] Storie, R. Earl, *et al.* Soil survey of the Santa Cruz area, California. U. S. Dept. Agr. Bur. Chem. and Soils, Series 1935. (In press.)

DESCRIPTION OF COUNTY

Santa Cruz County, located in the central coast area of California about 60 miles south of San Francisco, has a total area of about 435 square miles, or 278,400 acres. Physiographically, the Santa Cruz Mountains comprise almost 74 per cent of the county, extending to an elevation of about 3,000 feet in the extreme northern corner. A series of old marine or alluvial terraces border the coast and extend back of the Pajaro Valley. These have an elevation from about 20 to 400 feet above sea level. They comprise a little over 15 per cent of the county. Only about 11 per cent of the county is valley land, the largest area being in the Pajaro Valley located at the southeastern edge.

The climate of Santa Cruz County is similar to that of the central coastal counties of California. All of the rain occurs during the colder season, the early fall rains beginning about November 1 and the last rains occurring about April 1. The summers are dry. Watsonville, in the Pajaro Valley, has a mean annual rainfall of about 23 inches and a mean annual temperature of 56.6° Fahrenheit. The city of Santa Cruz has a mean annual rainfall of about 27 inches and a mean annual temperature of 57.3° Fahrenheit. Weather stations in the upland portion of the county report a mean annual rainfall of from 35 to 65 inches. The redwood belt in general has a rainfall of over 40 inches. Summer fogs are common along the coast.

METHODS

Classifying Land into Natural Groups and Divisions.—For some time in California the author has been engaged in interpreting soil and other physical land data and then setting up this information into a smaller number of categories.[4] For broader studies in land use it appears desirable to delineate bodies of land having a uniformity of natural physical characteristics. In this system of classification the land is broken first into five broad physiographic groups lettered A, B, C, D, and E: symbol A, the alluvial fan and flood plains; B, the flatter basinlike land; C, the low terrace land; D, the high terrace land; and E, the upland or mountainous land (plate 1 and fig. 1). A standard set of colors for the map (plate 1) has been used and is: yellows for physiographic group A; greens for B; blues for C; purples for D; and pinks and reds for E.

Within each broad physiographic group are found the *natural land divisions,* each of which is a land unit having a particular set of natural

[4] Storie, R. Earl. The place of soil studies in land classification and land use. Agr. Engin. 18(11):493–94. 1937.

characteristics, such as topography, soil, drainage, erosion, and climate. These characteristics of the natural land divisions also define the natural productivity of land for plant growth whether it be cultivated crops, grass, or timber (fig. 2). The standard detailed soil survey is used as a base for setting up this type of natural land division. Soil-type ratings as determined by means of the Storie index[5] are used as a guide for this classification, and a study of the natural vegetation and climate also contributes certain information. The natural land divisions with similar soil

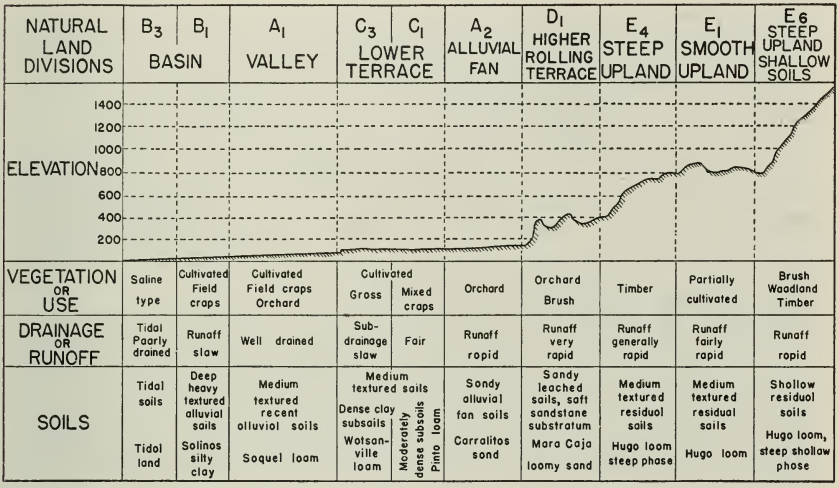


Fig. 1.—Profile across southeastern part of Santa Cruz County showing relation between topography, vegetation, and soils.

types grouped together, designated and arranged in descending order on the basis of agricultural quality of the soils, are shown by subscript figures, the best agricultural soils in each group being designated by the lowest subscript. Thus the soils of the A_1 division are of better agricultural quality than the soils of the A_2 division, and the soils of the B_1 division are similarly better than those of the B_2 division. The results of this classification will be discussed in detail later in this paper under the headings of the broad physiographic groups. Tables 1 to 5 describe the natural land divisions of Santa Cruz County and give the soil types in each division.

Determining Utilization.—In order to determine specifically just how the various groups of soils in Santa Cruz County are being used, the natural-land-division map was superimposed on the land-use map of

[5] Storie, R. Earl. An index for rating the agricultural value of soils. California Agr. Exp. Sta. Bul. 556:1–48. Revised 1937.

1936 and measurements made of the kind of crops, the natural cover, and other uses. This gives a picture of the present use of the soils of the county, not by political subdivisions which are changeable, but by natural physical land divisions which are of permanent status. These measurements are reported in tables 6, 7, and 8. In table 6 the utilization of each natural land division is reported as orchard, vineyard, lettuce, artichokes and Brussels sprouts, berries and miscellaneous small fruits, general field and truck crops, grass, timber, woodland, brush, recreation,

Fig. 2.—Recent alluvial soils (A_1) in foreground being utilized for field crops and apples; residual soils on lower hills (E_1) being used for pasture; and timber use on higher areas (E_4, E_5). Wise utilization of land.

urban, and suburban. Under the heading "Orchard" are included apples, pears, prunes, and apricots. Vineyard was measured separately. Berries and miscellaneous small fruits includes strawberries, bush berries, and other miscellaneous small plantings. Under general field crops are included sugar beets, corn, and miscellaneous field and truck crops. Grass includes natural grassland as well as older cultivated areas that have been allowed to grow up to grass. Timber includes redwood, Douglas fir, and small areas of ponderosa pine. The principal species of the woodland type are tanbark oak, live oak, and madrone. Brush includes toyon berry, manzanita, wild lilac, scrub oak, mountain mahogany, and poison oak.

The recreational-use classification in table 6 is based on a field survey conducted coöperatively by the United States Forest Service and the Resettlement Administration. Land in the recreational-use classification is that having value for camp sites or as beach resorts. Much of that

classed as recreational in the upland area has a timber and woodland cover. In the urban-use classification is the town and city property, and in the suburban-use classification are many small 1- and 2-acre farms. Figures 4, 8, 9, 11, and 15, show graphically the proportional use of each natural land division, and figures 23, 24, 25, and 26 show the distribution of the various crops, cover types, and other uses on the different land divisions. The use of each land division is discussed in more detail later in the text.

Applying Storie Index.—The potential inherent quality of each soil type of Santa Cruz County, as expressed by means of the Storie index, was worked out after the completion of the soil survey in 1935 (tables 1 to 5). A soil-grade map is shown in figure 3 in which all the soil types and phases have been placed in six grades on the basis of their index rating. Thus grade 1 soils rate 80 to 100 per cent; grade 2 soils, 60 to 79 per cent; grade 3 soils, 40 to 59 per cent; grade 4 soils, 20 to 39 per cent; grade 5 soils, 10 to 19 per cent; and grade 6 soils, 0 to 9 per cent. Generally speaking, grade 1, 2, and 3 soils can best be used for agricultural crops; grade 4 soils usually have distinct agricultural problems when used for crops; and grade 5 and 6 soils are usually too steep or too shallow, or have other features that render them unfit for tilled crops.

Determining Productivity.—A knowledge of the relative productivity of the soils of any area is necessary in projecting any land-conservation or land-use studies. Studies were made to determine the actual production of a large number of apple orchards in the county. Results on apple production were secured from three sources: the apple-enterprise-efficiency studies of the University of California Agricultural Extension Service; production figures of the Farm Credit Administration; and from studies of the County Agricultural Commissioner. All of the apple orchards consisted of the Yellow Newtown (Newtown Pippin) or the Yellow Bellflower variety and were generally between twenty and forty years of age. Production is expressed in the number of 40-pound boxes per acre per year. These results, giving average annual production by natural land divisions, are shown in figure 7, and the relation between these figures and the Storie index is shown in figure 27.

More generalized yield data were secured from farmers and county agricultural workers for barley, beans, hay, sugar beets, alfalfa, artichokes, strawberries, and lettuce. The potential carrying capacity for grazing purposes of the various kinds of land was secured from estimates of agricultural workers of the county and also estimates of what the soils would produce in timber. Productivity ratings were then established for all these crops (table 9).

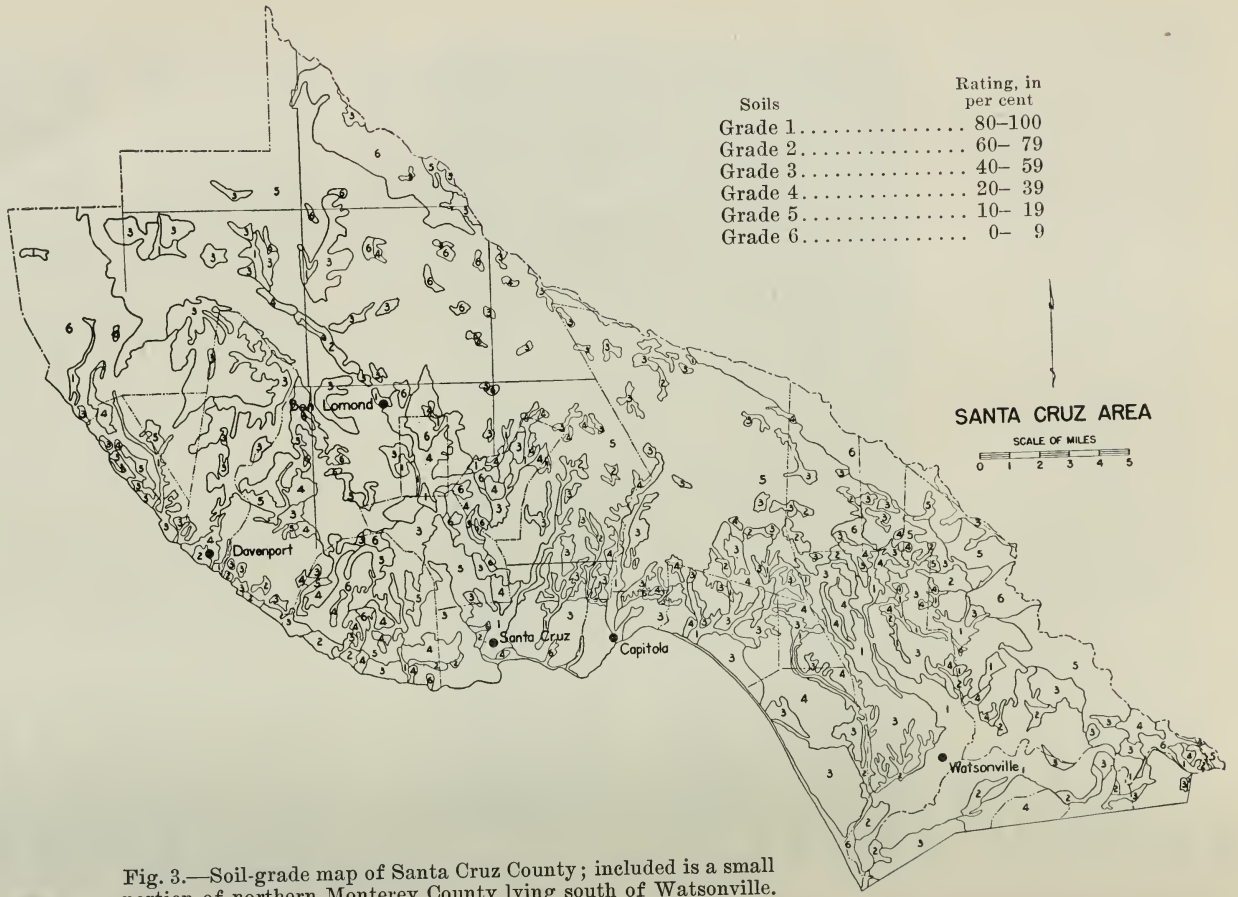


Fig. 3.—Soil-grade map of Santa Cruz County; included is a small portion of northern Monterey County lying south of Watsonville.

The rating compares the productivity of each natural land division for each crop to a standard 100, which stands for the inherent productivity for the most productive soils of Santa Cruz County for that crop. This productivity rating is based on the productivity under the prevailing farming practices of the county and assumes good management. Yields will be higher or lower than this standard according to local climatic differences and factors of management and fertilizers or soil amendments. An index of 50 indicates that the soils of that division are about half as productive as those with a 100 index. Some of the acre yields that have been set up as standards of 100 are given in the footnote of table 9. They represent average yields of crops of good quality on the best soils without the use of more than normal management practices.

The potential carrying capacity for grazing purposes is given in acres per animal month; or the number of acres of pasture land required to carry one steer per month. A soil able to support one animal on 0.8 of an acre per month or 10 acres for the year per animal rates 100. Land that would carry one animal per 20 acres rates 50. Being based on estimates, these ratings of grazing are not so complete as desirable, and further study may suggest changes.

In table 9 a set of symbols is used to express the general productive capacity or adaptation of the different land divisions for timber; symbol E indicating an excellent adaptation; G, good; F, fair; and P, poor.

The productivity ratings in table 9 bring out the physical adaptation of the various land divisions for the various uses and indicate some of the physical problems encountered in farming the land.

SMOOTH VALLEY LAND (A)

Physiographic group A is composed of alluvial soils that occupy alluvial fans or alluvial valley floors. The soils are characteristically more than 6 feet deep and consist of a mass of soil material that has not been modified to any extent by the action of soil weathering forces. Because of desirable physical features of soil depth, drainage, and smoothness of surface, the most valuable agricultural soils of California fall in this group. They occur on the flood plains and alluvial fans of many of the California streams and are especially valuable for orchards, vegetables, and deep-rooted field crops. Crop yields on the medium-textured soils of this group are particularly high. The steeper alluvial fans usually have sandier or gravelly soils that are not so desirable agriculturally as the smoother medium-textured soil types such as the loams and clay loams. Generally the soils of this physiographic group are not subject to any great losses by soil erosion such as occur in hill lands.

The most common California soils falling in physiographic group A are those of the Hanford, Yolo, Hesperia, and Sorrento series.

In Santa Cruz County, land in this physiographic group constitutes 27,086 acres, or 9.7 per cent of the total area (fig. 4). Twenty-one soil

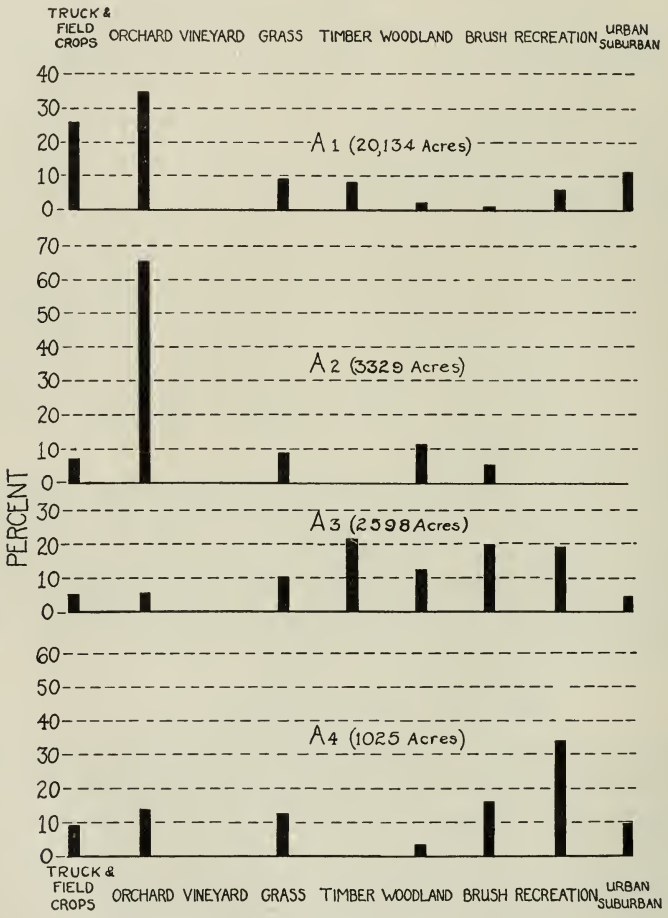


Fig. 4.—Utilization of the valley alluvial soils (natural land divisions A_1, A_2, A_3, A_4).

types and phases have been grouped into four natural land divisions. Soil series are the Corralitos, Metz, Salinas, Soquel, Pajaro, Botella, and Laguna. These are listed in table 1, and their distribution in the county shown in plate 1.

A_1, Deep, Recent Alluvial Soils of Medium Texture.—Soils of this division consist of the loams, fine sandy loams, silt loams, and clay loams of

the Corralitos, Metz, Soquel, Botella, Pajaro, and Salinas series. These soils occur in the Pajaro Valley (fig. 5) and in the narrower valleys in the vicinity of Aptos, Soquel, and north of the city of Santa Cruz (plate 1) where the mean annual rainfall is usually between 22 and 30 inches.

TABLE 1

Smooth Valley Land (A): Natural Land Divisions and Storie Index Rating of Soils; Santa Cruz County

Natural land divisions	Description	Soils	Storie index rating, in per cent
A_1	Deep alluvial soils of medium texture; generally of high fertility and adapted to the growth of many crops; extensively utilized for orchard, field and truck crops; high yields	Corralitos sandy loam	85
		Metz very fine sandy loam	80
		Metz very fine sandy loam, shallow phase (over Salinas soil material)	95
		Metz silt loam	90
		Metz silt loam, shallow phase (over Salinas soil material)	95
		Soquel sandy loam	90
		Soquel loam	95
		Soquel clay loam	81
		Pajaro sandy loam	90
		Pajaro loam	90
		Pajaro clay loam	77–90
		Botella clay loam	81
		Botella silty clay loam	86
		Salinas silty clay loam	87
A_2	Alluvial-fan land with deep sandy soils; subject to some cut and fill; utilized extensively for apples; moderate yields	Corralitos sand	54
		Corralitos sand, shallow phase (over Botella soil material)	54
		Metz fine sandy loam, light-textured inclusion	42
A_3	Alluvial slopes with deep sandy soils of low fertility; outwash from Arnold soils; timber (ponderosa pine) brush	Laguna fine sand	20–40
A_4	Very sandy or gravelly land; non-agricultural	Laguna fine sand, stone symbols	6
		Coastal beach and dunesand	3
		Riverwash	3

These soils constitute only 20,134 acres, or 7.2 per cent of the total area of the county, yet have 22.4 per cent of the cultivated crop acreage of the county. The soils are deep, of good water-holding capacity, fertile, and adapted to the production of a wide range of crops (table 9 and fig. 6). The Storie index rating on these soils is between 77 and 95 per cent.

About 53 per cent of the lettuce is grown on these soils and about 25 per cent of the orchards (table 7 and fig. 23). Table 9 indicates that the largest yields of all crops occur on these soils. Yellow Bellflower or Yel-

low Newtown apple trees usually yield between 800 and 1,500 boxes (of 40 pounds) per acre (fig. 28, *A*). The average apple production of 20 orchards on which production figures were secured between the years of 1931 and 1937 was about 1,100 boxes per acre (fig. 7).

In the Watsonville district, the Soquel, Pajaro, and Botella soils are used primarily for orchard purposes and the Salinas and Metz soils are

Fig. 5.—Utilization of the medium-textured, recent, alluvial soils (A_1) in the Pajaro Valley for lettuce and apples. Yields are high.

used for lettuce. A change has been made from apples and sugar beets to lettuce on a fairly large acreage during the past ten years owing to large profits in the lettuce industry. In the Soquel district there is a fairly large acreage of cherries on the Soquel loam. A considerable part of the cities of Watsonville and Soquel is located on these soils.

A_2, Deep, Alluvial-Fan Soils of Sandy Texture.—Soils of this division consisting of sands and loamy sands, primarily of the Corralitos series, are composed of recent outwash from the sandy hill lands. The soils have a low water-holding capacity, are acid in reaction and subject to some cut and fill in runoff from higher lands, and occur in a region having a mean annual rainfall of between 25 and 35 inches. These soils, located in the Corralitos district, in Larkin Valley, and other narrow valleys between Corralitos and Aptos, constitute 3,329 acres, or 1.2 per cent of the county. Sixty-six per cent, or 2,200 acres, is being utilized for orchard

Fig. 6.—Utilization of medium-textured, recent, alluvial soils (A_1) along Valencia Creek for apples and berries. Note redwood trees along stream channel.

purposes, chiefly apples. Ten apple orchards under study show an average annual yield of about 410 boxes per acre (table 10). According to the Storie index these soils rate between 42 and 54 per cent. The produc-

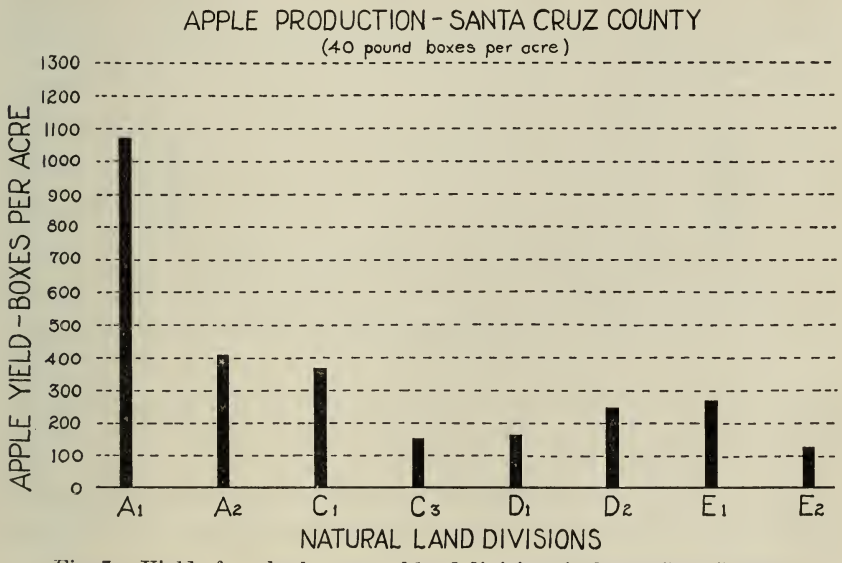


Fig. 7.—Yield of apples by natural land divisions in Santa Cruz County.

tion of crops is a little over half that on soils of the A_1 division (table 9). While fairly productive, these soils need to be carefully managed to maintain their fertility, and because of runoff from higher-lying lands they should be protected from erosion.

A_3, Deep, Sandy, Alluvial-Fan Soils of Low Fertility.—North of the city of Santa Cruz are alluvial-fan soils of light color, sandy texture, fairly high acidity, and, in general, of low fertility. These soils, derived as outwash from a white, soft sandstone, are classed as Laguna fine sand, and occur in a region having 35 to 50 inches of rainfall annually. They total 2,598 acres, or 0.9 per cent of the county. The soils are of low agricultural quality (table 9). About 75 per cent has a cover of ponderosa pine, knobcone pine, or brush, and only 11.7 per cent is under cultivation. They are being utilized to a considerable extent for summer cabin sites. These soils are subject to both erosion and deposition during heavy rains.

A_4, Very Sandy or Very Gravelly Land.—Coastal beach is the most extensive type in this division. Riverwash and dunesand occupy smaller areas. Approximately 0.4 per cent of the county, or 1,025 acres, is composed of this kind of land which is of nonagricultural character, although land-use measurements do show some acreage of crops. These generally are of very poor character. The coastal beach is generally used for recreational purposes.

BASINLIKE LAND (B)

The flatter basin lands of the valleys, or physiographic group B, generally occur below the alluvial-fan lands (A) on a smooth, flat relief. These soils of group B have been laid down by water or may be the result of the decomposition of plant life under poorly drained conditions. Both surface and subsurface drainage on these soils may be poor. There usually is a possibility of accumulations of alkali, or an excess of salts, on these soils, particularly in arid regions and on soils bordering tidal land. The better grades of basin soils are usually of dark color, high organic content, and fertile as far as plant nutrients are concerned, but being of heavy texture or not so well drained as the higher-lying alluvial soils, are better adapted to the culture of field and truck crops such as sugar beets, beans, hay, etc. Occasionally these basin lands have soils that are of older age with denser subsoils and in some instances lime hardpan layers. Generally speaking, these older basin soils are better adapted to pasture. Basin soils are usually not adapted to orchard or vine culture because of the poorer drainage factors.

Erosion generally is not a factor on these soils. Extensive California soils falling in this physiographic group are those of the Merced, Tulare, Pond, and Stockton series.

In Santa Cruz County, land in this physiographic group comprises 3,274 acres, or 1.2 per cent of the total area (fig. 8). It consists of heavy soils occupying the lower, flat areas, highly organic peat and muck soils,

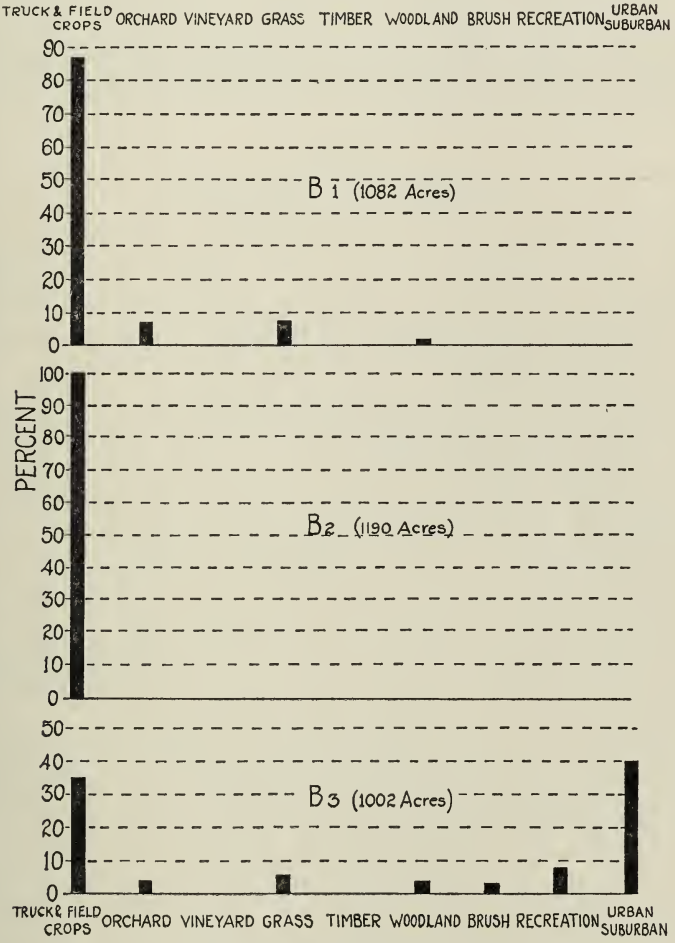


Fig. 8.—Utilization of the flatter basin land (natural land divisions B_1, B_2, and B_3).

poorly drained areas classed as marsh and swamp, or poorly drained saline soils classed as Alviso clay and tidal marsh. Six soil types have been combined into three natural land divisions (table 2).

B_1, Deep, Heavy-textured Soils.—These are the heavy soils in the Pajaro Valley consisting of Botella clay and Salinas silty clay. Both soil types occupy flat-surface topography, are dark colored and fertile, and

drainage is not so good as on the lighter-textured valley soils. These heavy soils occupy 1,082 acres, or 0.4 per cent, of the county. About 85 per cent of this acreage is used for field and truck crops, particularly lettuce, sugar beets, and beans. In 1935 and 1936 about 72 per cent was utilized for lettuce; previously it was used primarily for sugar beets. Yields are high. These soils are not so well adapted to orchard as they are to field-crop use because of poorer drainage and the possible salt content.

TABLE 2

BASINLIKE LAND (B): NATURAL LAND DIVISIONS AND STORIE INDEX RATING OF SOILS; SANTA CRUZ COUNTY

Natural land divisions	Description	Soils	Storie index rating, in per cent
B_1	Smooth land with deep heavy-textured soils; generally of high fertility; field-crop land	Botella clay	66
		Salinas silty clay	76
B_2	Smooth land having highly organic soils (peat); generally poorly drained; high fertility; adapted to field and truck crops	Muck and peat	50–80
B_3	Flat poorly drained land; bird life; recreational	Alviso clay	7
		Tidal marsh	3
		Marsh	5

The Storie index rating of these soils varies between 66 and 76 per cent, with the productivity rating for field crops being somewhat higher (table 9).

B_2, Highly Organic Soils.—This division consists of peat and muck soils that have been derived from the decomposition of a tule-reed vegetation in low, swampy, or poorly drained areas. These soils have a high organic content and a high water table. At times there is danger of the sinking or subsidence of these peat soils. When drained the agricultural value of peat and muck soils is fairly high, being adapted to the production of many field and truck crops including lettuce, beans, potatoes, and onions. A total of 1,190 acres, or 0.4 per cent of the county, is composed of peat and muck, much of it being located in Harkins Slough. At the present time nearly all of this type of material is being used for field and truck crops. These soils are not adapted to orchard or vineyard because of the high water table.

B_3, Flat, Poorly Drained Land.—This type of land occupies the tidal areas at the lower end of the Pajaro Valley and some of the sloughs, as well as fresh-water swamps at the lower end of some of the streams where

they join the tidal land. The flat tidal areas are classed as "tidal marsh" and as Alviso clay, both being highly saline and poorly drained. Fresh-water-swamp areas are designed as "marsh." A total of 1,002 acres, or 0.4 per cent of the county, is composed of this type of land.

The tidal areas have a cover of salt grass and other saline vegetation, whereas the marsh areas have a dense growth of tules or other fresh-water vegetation. A small amount of grazing is secured from the higher swamp areas, but the lower areas are used chiefly for wild bird life.

LOW TERRACE LAND (C)

The low terrace land, or physiographic group C, generally occurs at a somewhat higher elevation than the physiographic groups A and B. Group C is composed of older secondary soils that have weathered for a long period along with erosion and possibly some adjustment of the earth's crust, so that at the present time it stands apart as distinct terraces, or benches, usually occupying a position above the recent and young alluvial soils of the valley and below the residual soils of the upland (fig. 1). These terrace soils are variable in texture, according to the parent material and the stage of weathering. Usually the tops of these terraces are fairly smooth, although some may have an undulating surface or in some instances a hog-wallow relief. Usually the terrace soils are not so productive as the valley alluvial soils owing to their advanced age and stage of soil weathering with dense clay subsoils and in some instances hardpans.

Land in this physiographic group may be in a less frosty position than the lower, physiographic valley groups (A and B). The native cover in California is normally grass with a few trees.

Underground water is not so readily available under these soils as in the recent and young alluvial deposits. They are more costly to irrigate because of rougher surface in some soil types.

Some of the more common soil series occurring in California are the claypan soils of the Placentia, McClusky, and Antioch series, and the hardpan soils of the San Joaquin series.

In Santa Cruz County these terraces occur chiefly along the coast and also north of Watsonville at an elevation of from 20 to 200 feet above sea level. They are one of the most prominent physiographic land features of the county as viewed from a boat on the ocean. Because of their relatively smooth surface, location, and desirable climatic environment, a large portion of these terrace lands are used for agricultural, urban, and suburban purposes (fig. 9). The mean annual rainfall is generally between 22 and 30 inches.

The low terrace land has been classified into four natural land divisions composed of 13 distinct soil types (table 3 and fig. 9). The total area is 31,265 acres, or 11.3 per cent of the county. Santa Cruz County

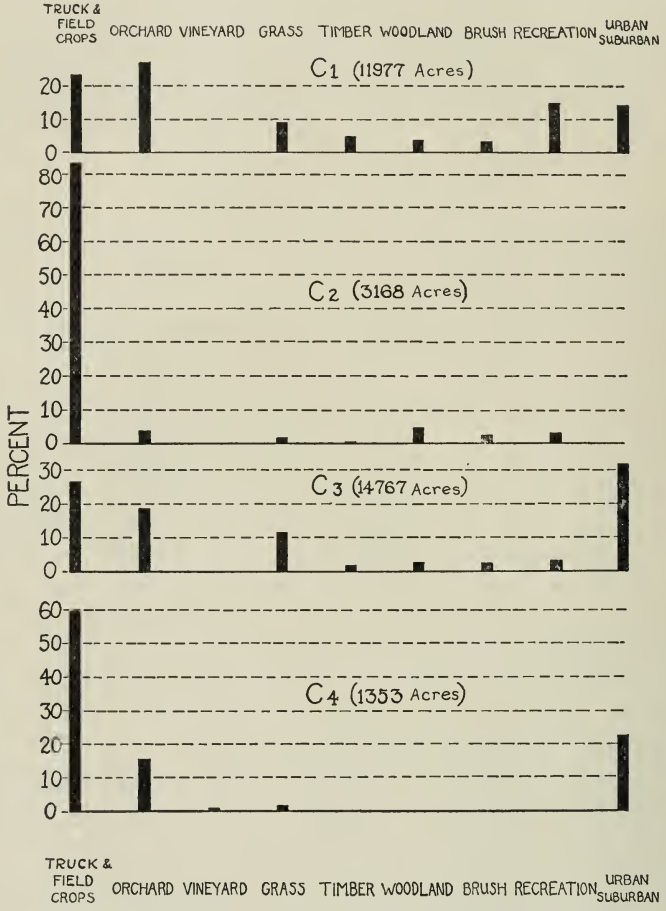


Fig. 9.—Utilization of the low terrace lands (natural land divisions C_1, C_2, C_3, and C_4).

soils falling in this group are the Ben Lomond, Pinto, Lockwood, Marina, Elkhorn, Watsonville, and Montezuma series.

C_1, Medium-textured Soils with Moderately Dense Subsoils.—Most of the land in this division occurs either north of Watsonville, or along the coast in the vicinity of Aptos and Capitola (plate 1), with smaller areas between Santa Cruz and Davenport and in the Boulder Creek district.

The soils are the medium-textured types of the Ben Lomond, Pinto,

and Lockwood series, the Pinto sandy loam and loam types making up a large part of the acreage. Soils of this division comprise 11,977 acres, or 4.3 per cent of the county. Approximately 23 per cent is being utilized for field and truck crops and 27 per cent for orchards. About 15 per cent is recreational and 14 per cent total urban and suburban. In general there has been very little change in use during the past forty years except for the increase in artichoke acreage. Twenty-two per cent of the acre-

TABLE 3

Low Terrace Land (C): Natural Land Divisions and Storie Index Rating of Soils; Santa Cruz County

Natural land divisions	Description	Soils	Storie index rating, in per cent
C_1	Smooth surface having medium-textured soils with moderately compact subsoils; of moderate fertility for most crops	Ben Lomond loam	76
		Pinto sandy loam	51
		Pinto loam	54
		Pinto clay loam	40
		Lockwood loam	64
C_2	Sandy soils of acid reaction; smooth to gently rolling surface; field crops; fair to low yields	Marina sand	42
		Elkhorn sandy loam	45
		Elkhorn loam	54
C_3	Medium-textured soils with dense clay subsoils; smooth surface; good for berries, artichokes, and field crops; orchard yields very low	Watsonville sandy loam	51
		Watsonville loam	45
		Watsonville clay loam	38
		Pinto loam, compact subsoil phase	41–45
C_4	Adobe clay soils, heavy clay subsoils; smooth to gently rolling surface; fertile soils but heavy to till; good field-crop land	Montezuma adobe clay	42

age of artichokes and Brussels sprouts occurs on the Pinto sandy loam and loam soils, which are located between Santa Cruz and Davenport (fig. 10). The soils of this division are generally of good productivity for most field crops such as beans, potatoes, corn, berries, artichokes, and Brussels sprouts (table 9). The soils rate between 40 and 76 per cent according to the Storie index. About 22 per cent of the total berry acreage, and over 20 per cent of the total suburban-use acreage occur on this land division. In the suburban-use classification are many small 1-acre farms in the vicinity of Capitola and Freedom.

Yields of fruit are not so high as on the A_1 natural land division. Apples normally yield between 300 and 500 boxes per acre on mature orchards. The average annual yield for 10 apple orchards from which figures were obtained was about 400 boxes per acre (figs. 7 and 28, *B*).

Soils of C_1 division appear to be particularly adapted to the production of bush berries (Logan, Young, Himalaya blackberries). There is usually slight to moderate erosion on cultivated areas having a slope of over 5 per cent.

C_2, Sandy Soils, Occupying a Smooth to Gently Rolling Surface.—Soils of this division are old sandy deposits that may be partly wind-

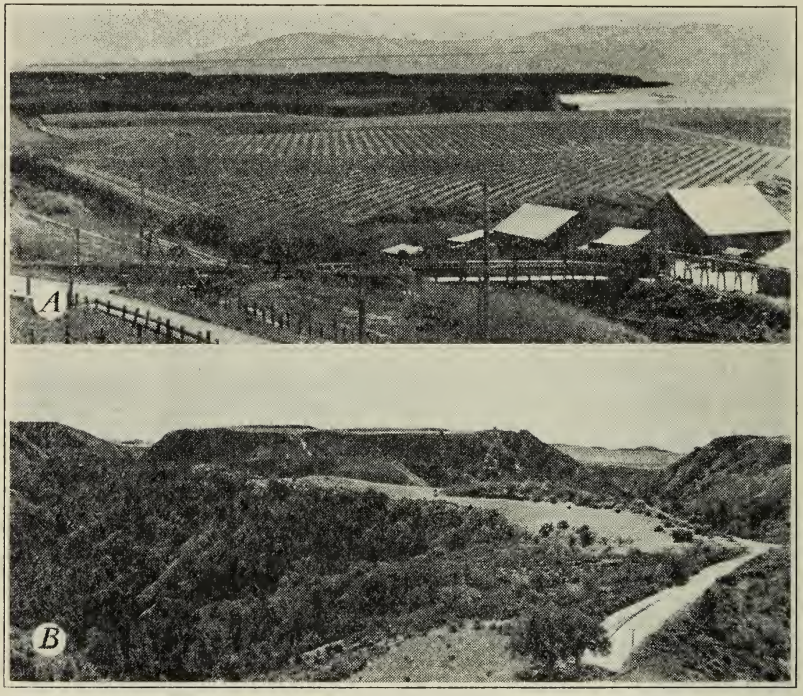


Fig. 10.—*A*, Artichokes on terraces between Santa Cruz and Davenport (C_1 and C_3 land divisions). *B*, Artichokes on low terrace land (C_1 and C_3 land divisions) and grass on high terrace land (D_2 land division). (Photographs by H. L. Washburn.)

blown, or aeolian, in character and partly alluvial. They are members of the Marina and Elkhorn series, the surface soils being of sand, loamy sand, or sandy loam texture, and the subsoils sandy but somewhat compact. The organic content is relatively low, and they are probably the most acid soils in the county. They occupy the sandy area lying west of Harkins Slough (plate 1), and comprise 3,168 acres, or 1.1 per cent of the county. They generally have a mean annual rainfall of about 23 inches. About 83 per cent is utilized for general truck and field crops such as hay, beans, canning peas, etc. There are no orchards. In general

there has been little change in use during the past fifty years. Crop yields are only fair (table 9); the content of available plant nutrients being low. The soils rate between 42 and 54 per cent according to the Storie index. There is some erosion on the sloping areas, particularly on the soils of the Elkhorn series which have the more compact subsoils.

C_3, *Medium-Textured Soils with Dense Clay Subsoils.*—Soils of this character occupy positions from 20 to 100 feet above sea level. The surface is generally smooth but untilled areas have a slightly irregular surface relief consisting of small mounds and depressions. Loams predominate for surface soils but subsoils at a depth of 15 to 30 inches consist of very dense clays. The entire profile is fairly acid in reaction. These soils comprise 14,767 acres, or 5.3 per cent of the county. At the present time about 32 per cent is classed as urban or suburban; about 27 per cent is in field and truck crops; almost 19 per cent is in orchard; and about 12 per cent is in grass. About 42 per cent of the artichokes and Brussels sprouts are grown on this land division (figs. 9 and 23). A climate particularly favorable to these crops rather than desirable soil properties probably is responsible for their extensive use. This development has come about in fairly recent years. Generally, orchards do not grow well because of the claypan. Production studies on 8 apple orchards show an average annual yield of 142 boxes per acre (figs. 7 and 29, *A*). Trees are smaller than those on the valley soils and do not have so healthy an appearance. The Storie index rating for these soils ranged between 38 and 51 per cent. They appear better adapted to the growth of berries and shallow-rooted field crops, and under virgin conditions are natural grassland rather than timberland. There is some slight to moderate erosion on cultivated areas having a slope of over 5 per cent.

C_4, *Adobe Clay Soils with Heavy Clay Subsoils.*—These lands have black adobe clay soils with heavy clay subsoils that carry considerable lime (Montezuma adobe clay). They are old alluvial soils occupying a position of 20 to 100 feet above the Pajaro Valley just west of Watsonville and occur in an area having a mean annual rainfall of about 23 inches. Another area is located in the outskirts of Santa Cruz. Their total area is 1,353 acres, or 0.6 per cent of the county. The surface relief is smooth to gently rolling. These soils absorb water fairly well in spite of their heavy texture and surface relief. At the present time about 60 per cent is in field and truck crops; about 15 per cent is in orchard; and about 22 per cent classed as urban. There has been little change in use during the past fifty years. This is a good grassland and general field-crop type (table 9). Generally, bush berries do fairly well, but deep-rooted crops such as orchards are not well adapted to these soils, which

are fertile but somewhat difficult to till. These soils have been given a Storie index rating of 42 per cent.

HIGH TERRACE LAND (D)

The high terrace land, or physiographic group D, usually occupies a position between the low terrace land C, and the upland E (fig. 1 and plate 1) at an elevation between 200 and 400 feet above sea level. Tops of these terraces may be fairly smooth, but usually the surface relief has

TABLE 4

HIGH TERRACE LAND (D): NATURAL LAND DIVISIONS AND STORIE INDEX RATING OF SOILS; SANTA CRUZ COUNTY

Natural land divisions	Description	Soils	Storie index rating, in per cent
D_1	Sandy soils of acid reaction underlain by soft sandstone substratum; rolling to fairly steep surface; very erosive; soils of low fertility	Moro Cojo loamy sand	33
		Moro Cojo sandy loam	38
		Moro Cojo sandy loam, dark-colored inclusion	30
		Moro Cojo sandy loam, heavy-textured inclusion	42
		Moro Cojo gravelly loam	25–40
		Moro Cojo gravelly loam, light-textured inclusion	17
D_2	Medium-textured soils with dense clay subsoils; terraces with smooth tops and fairly steep sides; erosive; good grassland	Tierra loam	32
		Tierra clay loam	31

been considerably changed by erosion forces; therefore the topography may be fairly irregular. The soils of this group usually are extremely variable in surface texture and in profile. Generally speaking, their agricultural value is low because of the leached surface, prevalence of heavy-textured subsoil, and the consolidated substratum which occurs in many soil types as well as the eroded topography. They are generally difficult to till without causing erosion losses.

Some of the soil series in California falling in this physiographic group are the Olivenhain, Las Flores, Tierra, Chamise, and Moro Cojo. Two natural land divisions have been set up in Santa Cruz County comprising eight different kinds of soils which are classed with the Moro Cojo and Tierra series (table 4). These total 11,195 acres, or 4.0 per cent of the county (fig. 11).

D_1, Sandy Soils Underlain by Soft Sandstone Substratum.—This natural land division has rolling to fairly steep surface relief and usually

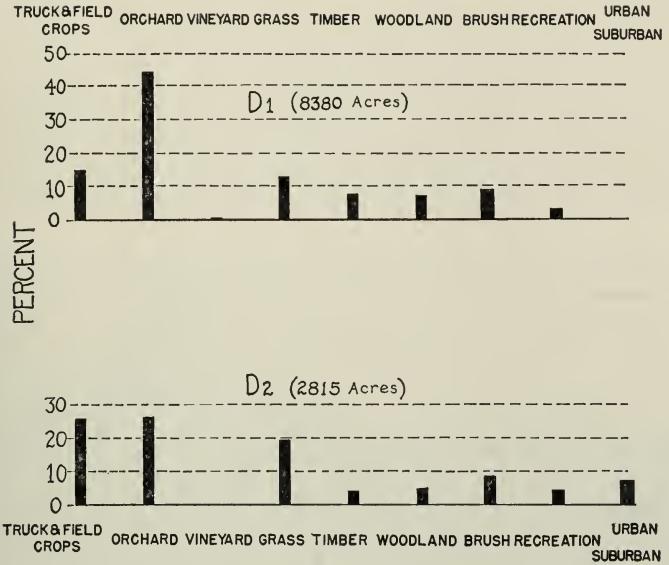


Fig. 11.—Utilization of high coastal terrace lands (natural land divisions D_1 and D_2).

very sandy soils that are acid in reaction, low in available plant nutrients, and very erosive (fig. 12). The Moro Cojo soils fall in this division. Soils of this character occur in the hills in the vicinity of Corralitos and the sandy hill area between Watsonville and Aptos where the mean an-

Fig. 12.—Moro Cojo soils (D_1) on hills being used for orchard and vineyard. Note eroded condition of soil and spotted condition of trees and vines. Bottomland soils of Botella and Salinas series (A_1) being used for lettuce and field crops.

nual rainfall is usually between 27 and 40 inches. They comprise 8,380 acres, or 3.0 per cent of the county. At the present time 44 per cent of the area is in orchard, principally apples; about 24 per cent is timber-woodland-brush complex; about 15 per cent is in field and truck crops; and about 13 per cent is cleared and carries a little grass and therefore is classed as grassland. Their Storie index rating is from 17 to 42 per cent. Neither grass nor field crops do very well, and the average annual

Fig. 13.—Erosion on Moro Cojo loamy sand after a heavy rain.

production of 20 orchards was only 172 boxes per acre (table 10). These are the most erosive soils in the county if not in the entire state (fig. 13). The Soil Conservation Service has been carrying on studies for some time on the best methods of controlling erosion on these soils. Runoff and erosion from the Moro Cojo soils cause damage to the more productive Corralitos sand (A_2 division) which lie below. Some of the orchards on this natural land division are being abandoned and the land allowed to grow up to brush.

D_2, Medium-textured Soils Underlain by Dense Clay Subsoils.—Land in this division has the form of distinct terraces with fairly smooth tops and fairly steep sides. The surface soils are usually of loam or clay loam

texture, fairly acid in reaction, and of moderate organic content. The very dense clay subsoils occur at depths of 8 to 15 inches from the surface and rest on a softly consolidated fine-textured substratum. These soils are known as the Tierra series and occur in regions having a mean annual rainfall of between 30 and 40 inches. They constitute 2,815 acres, or 1.0 per cent of the county. At the present time about 25 per cent is in field and truck crops; about 26 per cent in orchard; and about 19 per cent in

Fig. 14.—Apple orchard on high terrace soil of shallow depth having very dense clay subsoil. Eroded condition with very poor trees.

grass. Annual apple production averages between 100 and 400 boxes per acre. Shallow-rooted field crops or grasses appear to be better adapted to these soils than the deeper-rooted crops (table 9 and fig. 29, *B*). There is some gradual abandonment of orchards. These soils have been given a Storie index rating of 31 and 32 per cent. Erosion is very active on sloping areas that are barren of vegetation (fig. 14); therefore care must be exercised in farming these areas. This is a natural grassland type.

UPLAND (E)

The upland, or physiographic group E, generally has a rolling to steep topography. Soils in this group are residual in character, being formed in place from the decomposition and disintegration of the underlying bedrock, the soil texture depending chiefly on the texture of the bedrock.

TABLE 5

UPLAND (E): NATURAL LAND DIVISIONS AND STORIE INDEX RATING OF SOILS; SANTA CRUZ COUNTY

Natural land divisions	Description	Soils	Storie index rating, in per cent
E_1	Rolling topography; medium-textured residual soils of moderate depth to bedrock; acid soils; erosive when cleared; excellent timberland	Hugo sandy loam	36
		Hugo fine sandy loam	45
		Hugo loam	30–50
		Hugo clay loam	48
		Cayucos sandy loam	50
		Cayucos clay loam	54
		Cayucos loam	63
		Cayucos clay loam, heavy-textured phase	32
		Holland sandy loam	42
		Holland fine sandy loam	48
		Sheridan sandy loam	50
		Sheridan loam	56
		Felton loam	48
E_2	Rolling topography; dark-colored residual soils of rather shallow depth resting on Monterey shale bedrock; good grassland; some hay	Santa Lucia clay loam	32
		Santa Lucia clay	32
E_3	Rolling to fairly steep; light-gray sandy residual soils; strongly acid; low fertility; pine or brush	Arnold sand	10–20
E_4	Steep land; medium-textured residual soils; acid; too steep for tilled crops; timberland	Hugo sandy loam, steep phase	14
		Hugo fine sandy loam, steep phase	15
		Hugo clay loam, steep phase	13
		Hugo loam, steep phase	18
		Cayucos loam, steep phase	15
		Cayucos clay loam, steep phase	14
		Cayucos clay loam, steep phase (heavy-textured inclusion)	13
		Cayucos clay loam, heavy-textured phase	14
		Holland sandy loam, steep phase	11
		Holland fine sandy loam, steep phase	12
		Sheridan sandy loam, steep phase	13
		Sheridan loam, steep phase	14
		Felton loam, steep phase	10
E_5	Moderate to steep slopes; medium-textured residual soils of fairly shallow depth; timber, brush, some grazing	Hugo loam, shallow phase	8
		Felton stony sandy loam	8
		Santa Lucia clay loam, shallow phase	13
		Santa Lucia clay loam, steep phase	8
		Santa Lucia clay, steep phase	7
E_6	Steep slopes; residual soils of shallow depth and often stony; considerable brush; nonagricultural	Rough stony land, Hugo soil material	3
		Santa Lucia clay loam, steep shallow phase	2
		Santa Lucia clay loam, rock outcrop symbols	2
		Arnold sand, steep phase	4

LEGEND

SMOOTH VALLEY LAND

- A_1 — DEEP, MEDIUM-TEXTURED, ALLUVIAL SOILS OF HIGH FERTILITY
- A_2 — DEEP, SANDY, ALLUVIAL FAN SOILS OF MODERATE FERTILITY
- A_3 — DEEP, SANDY, ALLUVIAL FAN SOILS OF LOW FERTILITY
- A_4 — RIVERWASH, COASTAL BEACH, DUNESAND NON-AGRICULTURAL

BASIN LAND

- B_1 — DEEP, HEAVY-TEXTURED SOILS OF HIGH FERTILITY
- B_2 — HIGHLY ORGANIC SOILS - PEAT HIGH FERTILITY WHEN DRAINED
- B_3 — POORLY DRAINED - TIDAL LAND, MARSH GENERALLY NON-AGRICULTURAL

HIGH TERRACE LAND

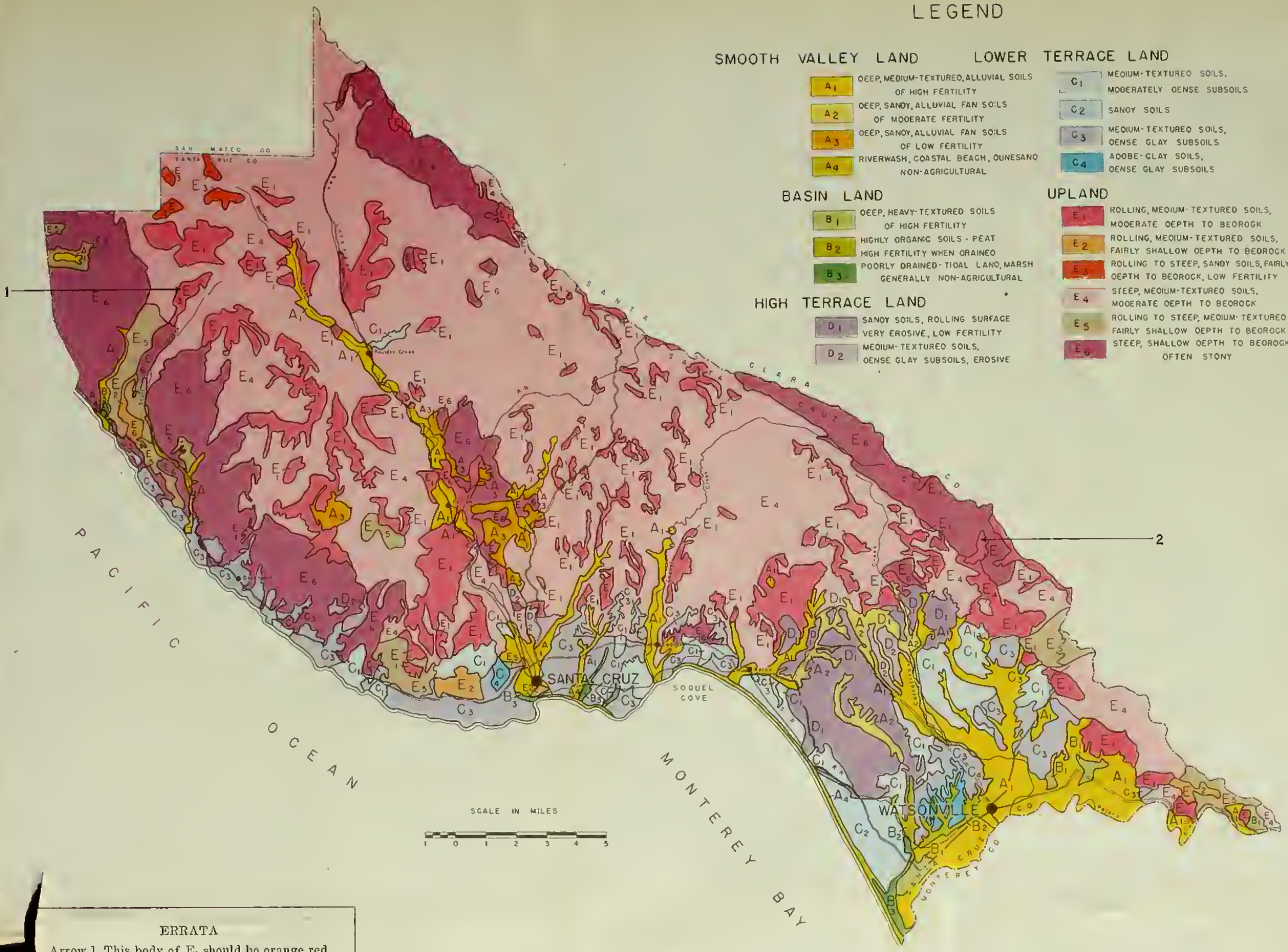
- D_1 — SANDY SOILS, ROLLING SURFACE VERY EROSIVE, LOW FERTILITY
- D_2 — MEDIUM-TEXTURED SOILS, DENSE CLAY SUBSOILS, EROSIVE

LOWER TERRACE LAND

- C_1 — MEDIUM-TEXTURED SOILS, MODERATELY DENSE SUBSOILS
- C_2 — SANDY SOILS
- C_3 — MEDIUM-TEXTURED SOILS, DENSE CLAY SUBSOILS
- C_4 — ADOBE-CLAY SOILS, DENSE CLAY SUBSOILS

UPLAND

- E_1 — ROLLING, MEDIUM-TEXTURED SOILS, MODERATE DEPTH TO BEDROCK
- E_2 — ROLLING, MEDIUM-TEXTURED SOILS, FAIRLY SHALLOW DEPTH TO BEDROCK
- E_3 — ROLLING TO STEEP, SANDY SOILS, FAIRLY SHALLOW DEPTH TO BEDROCK, LOW FERTILITY
- E_4 — STEEP, MEDIUM-TEXTURED SOILS, MODERATE DEPTH TO BEDROCK
- E_5 — ROLLING TO STEEP, MEDIUM-TEXTURED SOILS FAIRLY SHALLOW DEPTH TO BEDROCK
- E_6 — STEEP, SHALLOW DEPTH TO BEDROCK OFTEN STONY



ERRATA

Arrow 1. This body of E_3 should be orange red.
Arrow 2. This area should be light pink and labeled E_4 instead of E_1.

Plate 1.—Natural land divisions of Santa Cruz County.

Fine-textured rocks produce fine-textured soils, whereas coarse-textured rocks such as granites produce coarse-textured soils. These soils may sometimes be shallow or stony. These factors, together with the topography and surface configuration, generally determine their agricultural value and utilization. They are more difficult to farm than the terrace and valley soils and are subject to considerable erosion if clean-tilled. Generally speaking, conservation of this kind of land involves the use of permanent cover such as grass or timber. In areas where there is ample rainfall the deeper soils of the upland have a high productive capacity for timber. Many of the shallower soils have a brush cover.

Typical upland soils of California are the Sierra, Holland, Vista, Fallbrook, Aiken, Hugo, Santa Lucia, Cayucos, and Altamont series.

The Santa Cruz Mountains area has a rolling to steep topography with elevations varying from 200 to 3,000 feet above sea level. Santa Cruz County upland soils are those of the Hugo, Cayucos, Holland, Sheridan, Santa Lucia, Arnold, and Felton series. The soils are all of acid reaction and are formed under high rainfall (30 to 60 inches annually). The sandstone and shale rocks are the most extensive, giving rise to soils of the Hugo and Cayucos series, whereas the Arnold series are formed from light-colored sandstone, and the Santa Lucia from siliceous Monterey shale. The mica-schist rocks give rise to the Felton series of soils, and the granites produce the Holland and Sheridan soils.

This upland area comprises 205,580 acres, or 73.8 per cent of the county. Approximately 80 per cent has a timber-woodland-brush cover (figs. 15 and 25). This upland area has been separated into six natural land divisions, comprising 38 different soil types or phases (table 5).

E_1, Smoother Upland Having Medium-textured Soils of Moderate Depth to Bedrock.—These soils, occupying slopes of from 2 to 25 per cent, are scattered areas over the ridge tops and include the sandy loam, fine sandy loam, loam, and clay loam types of the Hugo, Cayucos, Holland, Sheridan, and Felton series. All are of acid reaction and usually rest on bedrock at a depth of from 2 to 4 feet (fig. 16). The mean annual rainfall where they occur is between 30 and 50 inches. This natural land division contains 34,889 acres, or 12.5 per cent of the county. According to the 1936 crop survey 19.7 per cent is cleared and is being utilized for crops; 14.1 per cent is in orchard; and 1.9 per cent in vineyard (table 8). The cover type and recreational survey brought out the fact that 67.1 per cent are essentially wild lands.

Production of orchards varies considerably according to slope, depth of soil, erosion, and management practices. Orchards on the darker-colored Cayucos soils (fig. 16) usually have more vigorous trees. Pro-

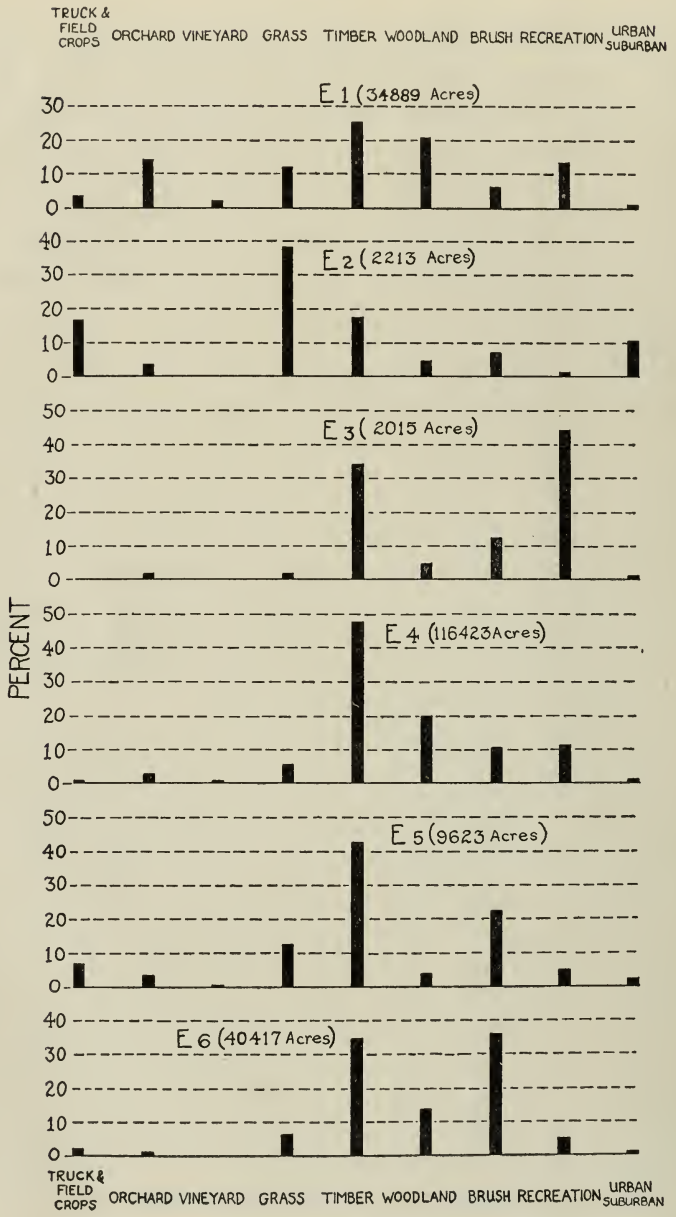


Fig. 15.—Utilization of upland soils (natural land divisions E_1, E_2, E_3, E_4, E_5, and E_6).

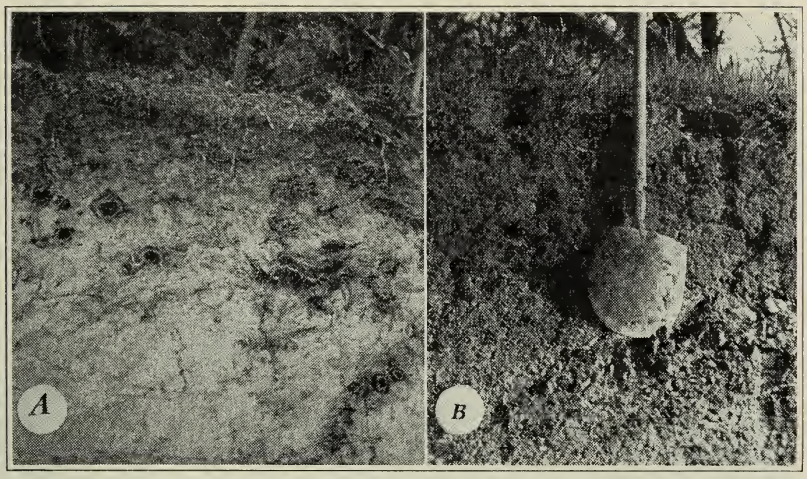


Fig. 16.—*A*, Profile of deep Cayucos loam soil (E_1) under virgin redwood cover. The dark-colored surface layer is generally quickly destroyed and eroded off under cultivation. *B*, Profile of Hugo loam (E_1) in an apple orchard. About 2 feet of soil overlies shale bedrock. (Photograph of part *B* by H. L. Washburn.)

duction studies of apples on 10 orchards show an average annual yield of 271 boxes per acre (table 10). In general, both prune and apple yields are decreasing on mature orchards on this type of land. This is probably

Fig. 17.—Upland area: redwood and orchard. Although the orchards are on the smoother slopes (E_1), there is considerable loss of soil by erosion. Note the uneven stand of orchard.

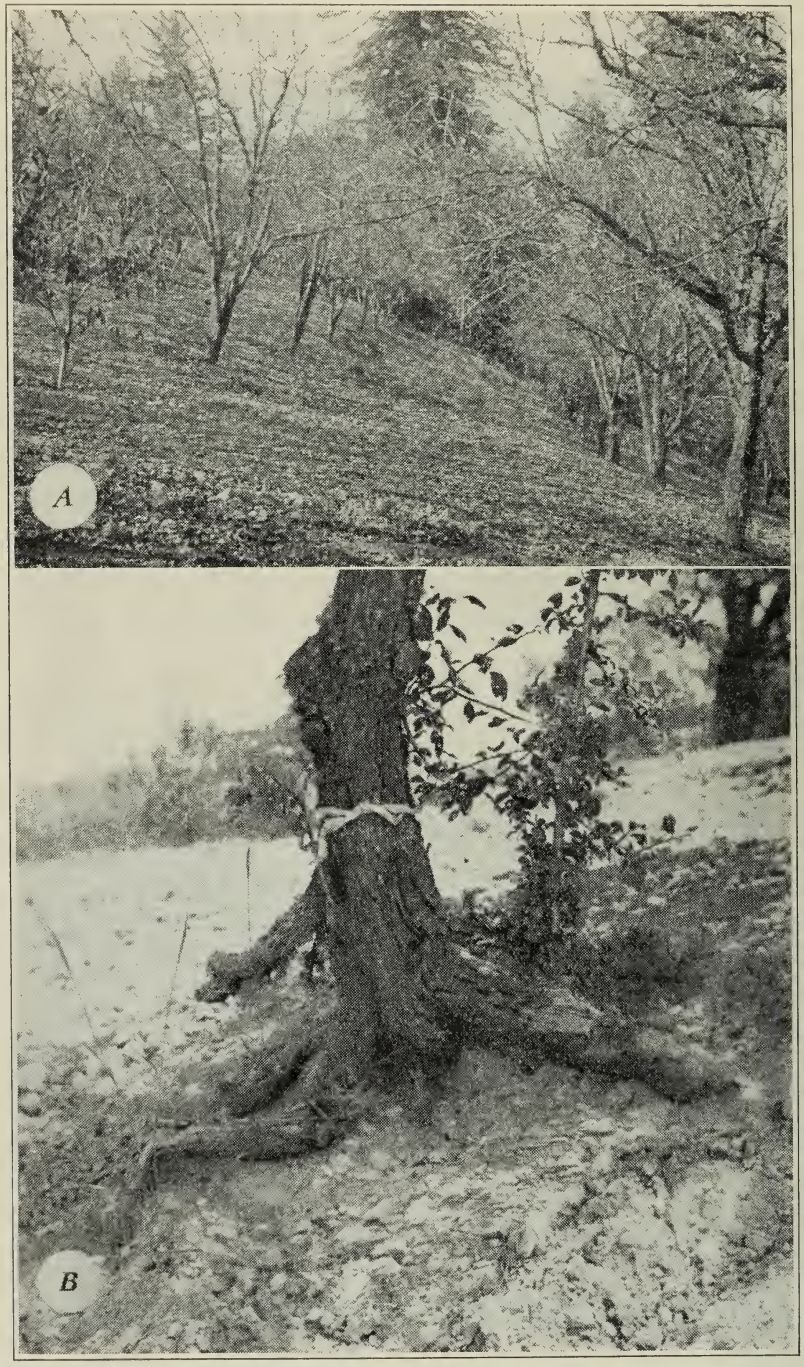


Fig. 18.—Upland soil—Hugo loam (E_1): *A*, orchard set out and cultivated on contour, which cuts down on soil erosion; *B*, badly eroded condition with bedrock exposed in foreground and a loss of about 12 inches of soil as indicated by string around trunk of tree.

due to loss of soil by erosion (fig. 17). Covercrops might help to check erosion, but consideration should be given to the amount of moisture such crops will use on these nonirrigated orchards. Only on the areas having deeper, better soils can orchard yields be maintained. At the present time there is considerable abandonment of the poorer orchards.

These soils have been given a Storie index rating of between 30 and 63 per cent, the rate depending upon variations in soil depth, slope, and erosion. Areas are being farmed on which the soil is too shallow or the

Fig. 19.—Poor orchard on steep slopes in upland area. All of the dark-colored surface soil has been removed by erosion.

slope too steep for profitable production (figs. 18 and 19). Conservation of such areas would involve the use for permanent cover such as timber. These soils have a high productive capacity for timber, especially redwood and Douglas fir (table 9).

E_2, Smoother Upland Having Dark-colored, Medium-textured Soils of Rather Shallow Depth.—These dark-colored soils have been derived from the disintegration of Monterey shale. They are of rather shallow depth to bedrock (1 to 2 feet) and usually have angular shale fragments throughout the soil profile (fig. 20). These soils are not so acid as the higher timber-covered soils and occur in regions having a mean annual rainfall of between 25 and 30 inches. They have been classified as Santa Lucia clay loam and clay. Land in this division comprises 2,213 acres, or 0.8 per cent of the county. According to the utilization and cover-type studies 38.0 per cent is in grass; 16.8 per cent is being utilized for field

and truck crops; and 17.3 per cent for timber (table 8). Hay and beans are the principal field crops, and considering the depth of soil, yields are fairly good. These soils produce a good grass growth. In order to prevent erosion and conserve these as good grasslands, it appears desirable that they should remain in grass rather than be tilled. A Storie index rating of 32 per cent has been given these soils.

Fig. 20.—Soil profile of Santa Lucia clay loam (E_2); about 1½ feet in depth to Monterey shale bedrock.

E_3, Rolling Upland Having Light-gray, Sandy, Leached Soils.—These light-colored sandy soils have been derived from the weathering in place of a light-colored soft sandstone occurring at a depth of 1 to 4 feet from the surface. They are highly acid, extremely low in available nutrients, and subject to considerable erosion. They are classified as Arnold sand, and comprise 2,015 acres, or 0.7 per cent of the county. Areas occur east of Felton and Ben Lomond and in the Bonny Doon district, where the mean annual rainfall is between 35 and 50 inches. Utilization and cover-type studies show 34.3 per cent in timber, principally ponderosa and knobcone pine; 12.7 per cent in brush; and 44.0 per cent being used for recreational purposes. Much of this recreational portion has considerable ponderosa and knobcone pine. These soils have been given a Storie index rating of 10 to 20 per cent. In general they are not of sufficient fertility for agricultural use (fig. 21) except with the expenditure of undue amounts for fertilizers and for erosion control.

E_4, Steep Upland Composed of Medium-textured Soils of Good Depth to Bedrock.—The soils of this division, extending over a large part of the mountainous land of Santa Cruz County, include the sandy loam, fine sandy loam, loam, and clay loam soils of the Hugo, Cayucos, Holland, Sheridan, and Felton series that have been classed as steep phases. Slopes are generally between 25 and 50 per cent. This area has a mean annual rainfall of between 30 and 60 inches. A total of 116,423 acres, or 41.9

per cent of the county, is included in this division. According to the utilization and cover-type studies 47.3 per cent is in timber; 20.9 per cent in woodland; 10.3 per cent in brush; and 10.9 per cent recreational. By counting the land in the recreational-use classification as being chiefly wild land, a total of about 89 per cent is timber-woodland-brush. About

Fig. 21.—Redwood, brush, and vineyard on upland area (E_1, E_3). Brush occurs on the shallower, sandier soils.

64 per cent of the total timber of the county and about 60 per cent of the woodland is on this land division (table 7). Slopes are generally too steep for tilled crops, yet there are some orchards and vineyards. Soil loss by erosion is unusually high in these plots. This is a distinct timber type with a high productive capacity particularly for redwood and Douglas fir (table 9). Soils of this division have been given a Storie index rating of between 10 and 18 per cent.

E_5, Rolling to Steep Upland Composed of Medium-textured Soils of Fairly Shallow Depth to Bedrock.—Soils of this division are chiefly the shallow phases of the Hugo loam, Santa Lucia clay loam, and Santa Lucia clay. They occupy moderate to steep slopes and have a mean annual rainfall of between 30 and 60 inches. In this land division is a total of 9,623 acres, or 3.4 per cent of the county, which generally occurs along the southern or western edge of the upland area. According to the utilization and cover-type studies 42.7 per cent is in timber; 22.6 per cent in brush; and 12.5 per cent in grass (table 8). Usually the timber is not of

such good quality as that on E_4 division, there being a considerable acreage of knobcone pine (fig. 22). Although there are some scattered plantings of orchards, vines, and field crops on the better areas of these soils, recommendation for any further plantings is not advisable because of shallow soil depth, fairly steep slopes, and danger of erosion. Some of the

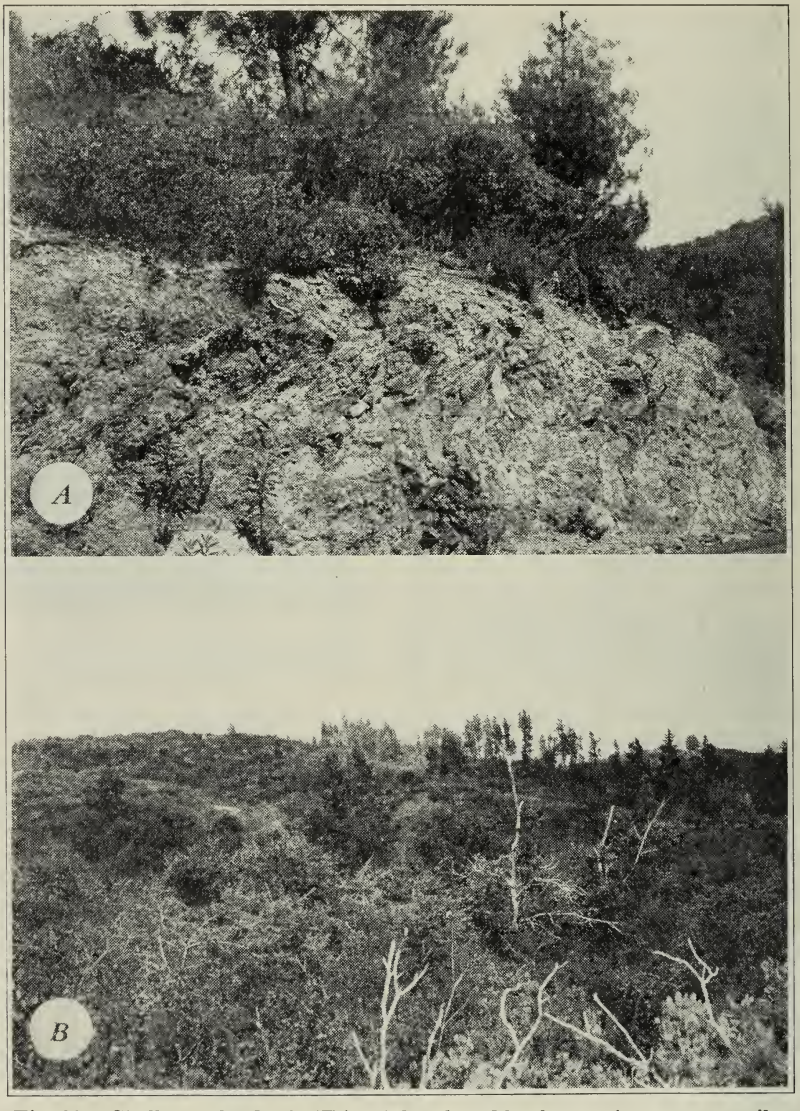


Fig. 22.—Shallow upland soil (E_5): *A*, brush and knobcone-pine cover on soils too shallow for crop use; B, brush, woodland, and knobcone-pine cover.

darker-colored soils in this division, especially those of the Santa Lucia series, have a fairly good grazing capacity. Soils in this division have been given a Storie index rating of between 7 and 13 per cent.

E_6, Steep Upland Having Soils of Very Shallow Depth to Bedrock and Often Stony.—The soils in this division are the steep, shallow phases of Santa Lucia clay loam, Arnold sand, and areas classed as rough stony land. Considerable areas occur along the crest of the Santa Cruz Mountains on the Santa Clara County line, east of Ben Lomond and Felton; and northwest of Santa Cruz. These areas have a mean annual rainfall of between 35 and 50 inches. The total acreage is 40,417, or 14.5 per cent of the county. According to utilization and cover-type studies, 36.0 per cent is in brush; 34.4 per cent in timber; and 13.7 per cent woodland (table 8). The areas along the Santa Clara County line are chiefly brush-covered, whereas the district east of Ben Lomond and Felton, classified as Arnold sand, steep phase, has primarily a ponderosa pine, knobcone pine, and brush cover. The areas along the coast northwest of Santa Cruz have good timber in the ravines but the tops of the ridges are barren except for some grass. These soils have a Storie index rating of 2 to 4 per cent. They are nonagricultural in character.

RELATION BETWEEN NATURAL LAND DIVISIONS AND UTILIZATION

As shown in tables 6, 7, 8, and figure 23 orchard comprises a total of 29,647 acres, or 10.6 per cent of the county. Of this, 7,277 acres, or 24.5 per cent is located on A_1 land division; 4,936 acres, or 16.7 per cent on E_1; 3,686 acres, or 12.4 per cent on D_1; 3,253 acres, or 11.0 per cent on C_1; 3,044 acres, or 10.3 per cent on E_4; 2,774 acres, or 9.4 per cent on C_3; and 2,200 acres, or 7.4 per cent on A_2 division. Much smaller acreages occur on the other land divisions. Thus the A_1 land division, which makes up 7.2 per cent of the county, has 24.5 per cent of the orchard acreage. This is much more productive than the other divisions.

Of the 1,823 acres of vineyard, 47.6 per cent is located on E_4 natural land division, and 35.7 per cent on E_1 (table 7). Over 92 per cent of the vineyard occurs on the upland.

Of the 8,000 acres of lettuce, 4,222 acres, or 52.8 per cent, occur on A_1 division; 902 acres, or 11.3 per cent on C_3; and 784 acres, or 9.8 per cent on B_1 (table 7). Thus 21.0 per cent of A_1 division is in lettuce, 72.5 per cent of B_1; and 25.2 per cent of B_2 (table 8.)

Of the 3,768 acres of artichokes and Brussels sprouts, 41.7 per cent are on C_3 land division and 22.0 per cent on C_1 (table 7). Both of these divisions are on low terrace land between Santa Cruz and Davenport.

TABLE 6

UTILIZATION OF THE NATURAL LAND DIVISIONS OF SANTA CRUZ COUNTY, CALIFORNIA

Natural land divisions	Total	Orchard	Vineyard	Truck and field crops					Total cultivated	Grass	Timber	Woodland	Brush	Recreation	Urban	Suburban
				Lettuce	Artichokes and Brussels sprouts	Berries and miscellaneous	Field crops	Total truck and field crops								
	acres	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*
A_1	20,134	7,277	16	4,222	401	69	527	5,219	12,512	1,581	1,316	517	364	1,387	2,134	323
A_2	3,329	2,200	0	127	0	72	34	233	2,433	297	12	392	183	12	0	0
A_3	2,598	156	11	7	0	7	123	137	304	269	570	323	518	494	0	120
A_4	1,025	161	0	0	0	5	87	92	253	131	0	35	163	343	40	60
B_1	1,082	68	0	784	0	0	131	915	983	78	0	21	0	0	0	0
B_2	1,190	0	0	300	0	415	475	1,190	1,190	0	0	0	0	0	0	0
B_3	1,002	35	0	352	0	0	0	352	387	56	2	40	32	85	130	270
C_1	11,977	3,253	5	527	830	298	1,154	2,809	6,067	1,052	543	425	379	1,813	571	1,127
C_2	3,168	112	0	0	36	0	2,605	2,641	2,753	56	20	155	89	95	0	0
C_3	14,767	2,774	5	902	1,569	225	1,284	3,980	6,759	1,761	299	410	329	495	2,769	1,945
C_4	1,353	210	12	283	0	0	523	806	1,028	28	0	0	0	0	297	0
D_1	8,380	3,686	77	251	0	14	983	1,248	5,011	1,080	640	620	761	268	0	0
D_2	2,815	743	9	227	0	0	487	714	1,466	541	110	140	236	120	55	147
E_1	34,889	4,936	653	0	0	75	1,216	1,291	6,880	4,235	9,038	7,322	2,271	4,773	130	240
E_2	2,213	72	0	0	98	0	275	373	445	840	383	98	170	41	200	36
E_3	2,015	29	0	0	0	0	0	0	29	33	690	102	255	887	0	19
E_4	116,423	3,044	868	18	0	133	704	855	4,767	6,557	55,014	24,290	12,011	12,747	160	877
E_5	9,623	326	47	0	295	0	363	658	1,031	1,200	4,108	388	2,175	471	145	105
E_6	40,417	565	120	0	539	17	375	931	1,616	2,553	13,890	5,537	14,573	2,005	60	183
Total	278,400	29,647	1,823	8,000	3,768	1,330	11,346	24,444	55,914	22,348	86,635	40,815	34,509	26,036	6,691	5,452

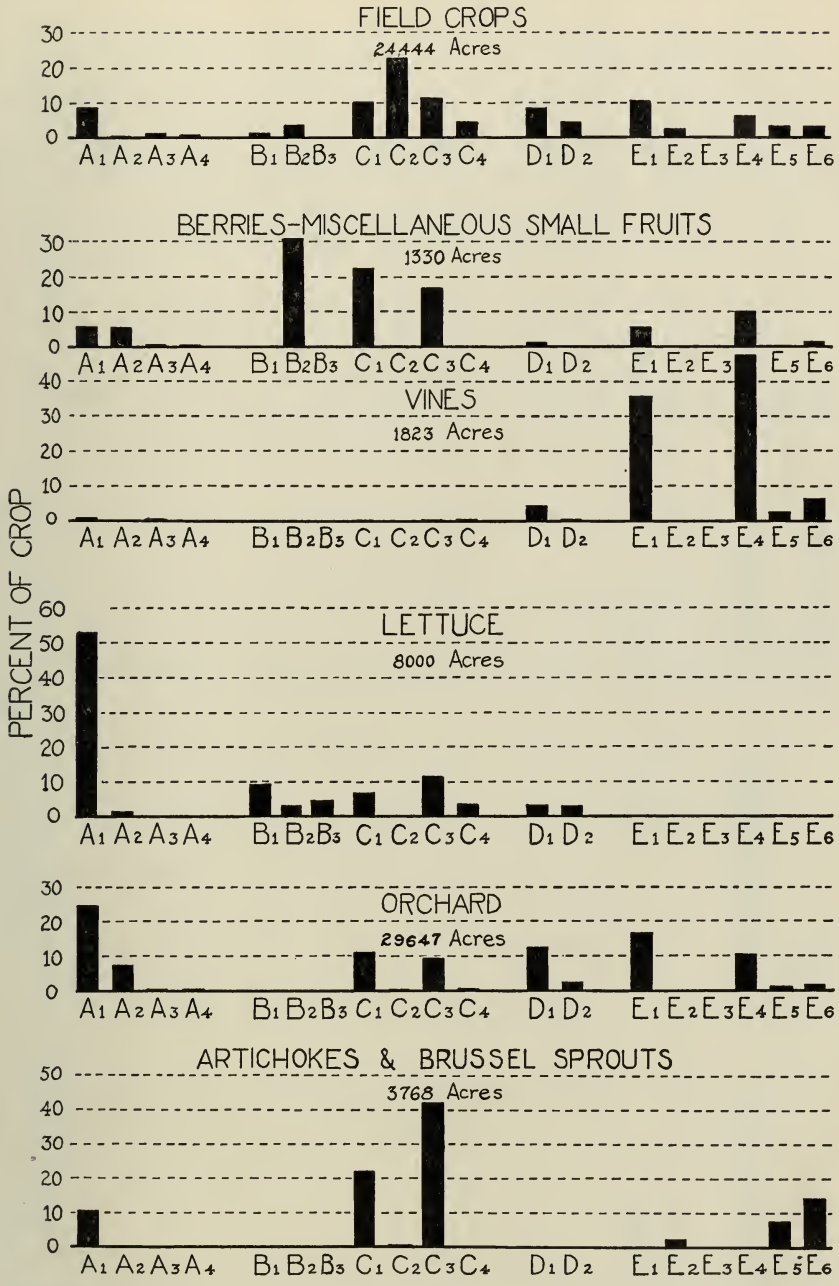


Fig. 23.—Distribution of various cultivated crops (miscellaneous field and truck crops, berries, and miscellaneous small fruits, vines, lettuce, orchard, and artichokes and Brussels sprouts) on the various natural land divisions.

TABLE 7

PERCENTAGE DISTRIBUTION OF NATURAL LAND DIVISIONS BY CROPS; SANTA CRUZ COUNTY, CALIFORNIA

Natural land divisions	Total	Orchard	Vineyard	Truck and field crops					Total cultivated	Grass	Timber	Woodland	Brush	Recreation	Urban	Suburban
				Lettuce	Artichokes and Brussels sprouts	Berries and miscellaneous	Field crops	Total truck and field crops								
	per cent	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*
A_1	7.2	24.5	0.9	52.8	10.6	5.2	4.6	21.4	22.4	7.1	1.5	1.3	1.1	5.3	31.9	5.9
A_2	1.2	7.4	0.0	1.6	0.0	5.4	0.3	0.9	4.4	1.3	0.0*	1.0	0.5	0.0*	0.0	0.0
A_3	0.9	0.5	0.6	0.1	0.0	0.5	1.1	0.6	0.5	1.2	0.7	0.8	1.5	1.9	0.0	2.2
A_4	0.4	0.6	0.0	0.0	0.0	0.4	0.8	0.4	0.5	0.6	0.0	0.1	0.5	1.3	0.6	1.1
B_1	0.4	0.2	0.0	9.8	0.0	0.0	1.2	3.7	1.8	0.4	0.0	0.1	0.0	0.0	0.0	0.0
B_2	0.4	0.0	0.0	3.8	0.0	31.2	4.2	4.9	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B_3	0.4	0.1	0.0	4.4	0.0	0.0	0.0	1.4	0.7	0.3	0.0*	0.1	0.1	0.3	1.9	4.9
C_1	4.3	11.0	0.3	6.6	22.0	22.4	10.2	11.5	10.8	4.7	0.6	1.0	1.1	7.0	8.6	20.7
C_2	1.1	0.4	0.0	0.0	1.0	0.0	22.9	10.8	4.9	0.3	0.0*	0.4	0.3	0.4	0.0	0.0
C_3	5.3	9.4	0.3	11.3	41.7	16.9	11.3	16.3	12.1	7.9	0.4	1.0	0.9	1.9	41.4	35.7
C_4	0.6	0.7	0.7	3.5	0.0	0.0	4.6	3.3	1.8	0.1	0.0	0.0	0.0	0.0	4.4	0.0
D_1	3.0	12.4	4.2	3.1	0.0	1.1	8.7	5.1	9.0	4.8	0.7	1.5	2.2	1.0	0.0	0.0
D_2	1.0	2.5	0.5	2.8	0.0	0.0	4.3	2.9	2.6	2.4	0.1	0.3	0.7	0.5	0.8	2.7
E_1	12.5	16.7	35.7	0.0	0.0	5.6	10.7	5.3	12.3	18.9	10.4	17.9	6.6	18.3	1.9	4.4
E_2	0.8	0.2	0.0	0.0	2.6	0.0	2.4	1.5	0.8	3.8	0.4	0.2	0.5	0.2	3.0	0.7
E_3	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.8	0.2	0.7	3.4	0.0	0.3
E_4	41.9	10.3	47.6	0.2	0.0	10.0	6.2	3.5	8.5	29.3	63.7	59.5	34.8	49.0	2.4	16.1
E_5	3.4	1.1	2.6	0.0	7.8	0.0	3.2	2.7	1.8	5.4	4.7	1.0	6.3	1.8	2.2	1.9
E_6	14.5	1.9	6.6	0.0	14.3	1.3	3.3	3.8	2.9	11.4	16.0	13.6	42.2	7.7	0.9	3.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Less than 0.05.

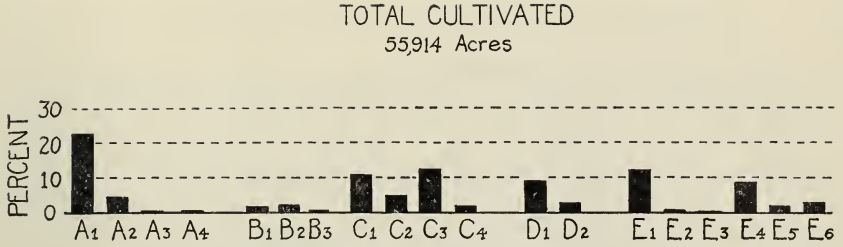


Fig. 24.—Distribution of the total cultivated crops by natural land divisions.

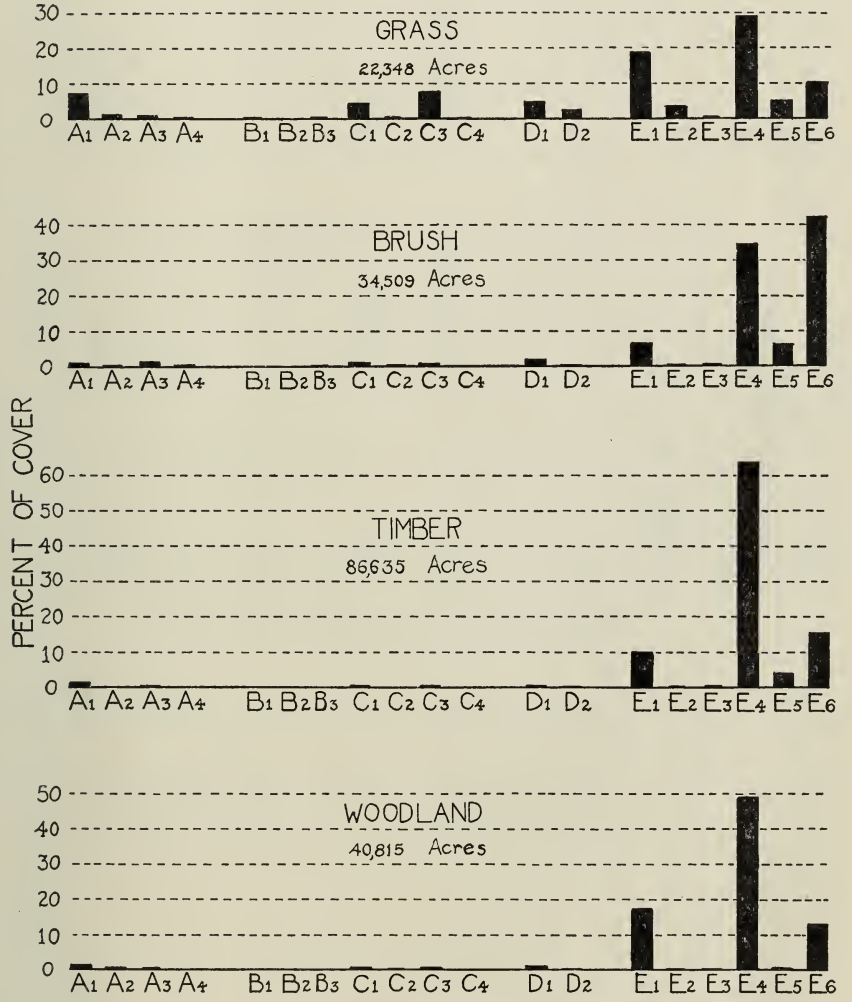


Fig. 25.—Distribution of the natural vegetation (grass, brush, timber, and woodland) on the natural land divisions.

TABLE 8

PERCENTAGE DISTRIBUTION OF CROPS BY NATURAL LAND DIVISIONS, SANTA CRUZ COUNTY, CALIFORNIA

Natural land divisions	Total	Orchard	Vineyard	Truck and field crops					Total cultivated	Grass	Timber	Woodland	Brush	Recreation	Urban	Suburban
				Lettuce	Artichokes and Brussels sprouts	Berries and miscellaneous	Field crops	Total truck and field crops								
	per cent	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*	*percent*
A_1	100.0	36.1	0.0*	21.0	2.0	0.3	2.6	25.9	62.0	7.9	6.6	2.6	1.8	6.9	10.6	1.6
A_2	100.0	66.0	0.0	3.8	0.0	2.2	1.0	7.0	73.0	8.9	0.4	11.8	5.5	0.4	0.0	0.0
A_3	100.0	6.0	0.4	0.3	0.0	0.3	4.7	5.3	11.7	10.4	21.9	12.4	20.0	19.0	0.0	4.6
A_4	100.0	15.7	0.0	0.0	0.0	0.5	8.5	9.0	24.7	12.8	0.0	3.4	15.9	33.5	3.9	5.8
B_1	100.0	6.3	0.0	72.5	0.0	0.0	12.1	84.6	90.9	7.2	0.0	1.9	0.0	0.0	0.0	0.0
B_2	100.0	0.0	0.0	25.2	0.0	34.9	39.9	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B_3	100.0	3.5	0.0	35.1	0.0	0.0	0.0	35.1	38.6	5.6	0.2	4.0	3.2	8.5	13.0	26.9
C_1	100.0	27.2	0.0*	4.4	6.9	2.5	9.6	23.4	50.6	8.8	4.5	3.6	3.2	15.1	4.8	9.4
C_2	100.0	3.5	0.0	0.0	1.1	0.0	82.3	83.4	86.9	1.8	0.6	4.9	2.8	3.0	0.0	0.0
C_3	100.0	18.8	0.0*	6.1	10.6	1.5	8.7	26.9	45.7	11.9	2.0	2.8	2.2	3.4	18.8	13.2
C_4	100.0	15.5	0.9	20.9	0.0	0.0	38.7	59.6	76.0	2.1	0.0	0.0	0.0	0.0	21.9	0.0
D_1	100.0	44.0	0.9	2.9	0.0	0.2	11.8	14.9	59.8	12.9	7.6	7.4	9.1	3.2	0.0	0.0
D_2	100.0	26.4	0.3	8.1	0.0	0.0	17.3	25.4	52.1	19.2	3.9	5.0	8.4	4.3	1.9	5.2
E_1	100.0	14.1	1.9	0.0	0.0	0.2	3.5	3.7	19.7	12.1	25.9	21.0	6.5	13.7	0.4	0.7
E_2	100.0	3.3	0.0	0.0	4.4	0.0	12.4	16.8	20.1	38.0	17.3	4.4	7.7	1.9	9.0	1.6
E_3	100.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.6	34.3	5.1	12.7	44.0	0.0	0.9
E_4	100.0	2.6	0.8	0.0*	0.0	-0.1	0.6	0.7	4.1	5.6	47.3	20.9	10.3	10.9	0.1	0.8
E_5	100.0	3.4	0.5	0.0	3.0	0.0	3.8	6.8	10.7	12.5	42.7	4.0	22.6	4.9	1.5	1.1
E_6	100.0	1.4	0.3	0.0	1.3	0.1	0.9	2.3	4.0	6.3	34.4	13.7	36.0	5.0	0.1	0.5
Total use	100.0	10.6	0.7	2.9	1.3	0.5	4.1	8.8	20.1	8.0	31.1	14.6	12.4	9.5	2.4	1.9

* Less than 0.05.

Strawberries, bush berries, and other small fruits make up 1,330 acres. The largest acreage of strawberries occurs on C_1 and C_3 divisions (table 6).

A total of 11,346 acres is in general field and truck crops, 44.4 per cent of which is on C_1, C_2, and C_3 divisions (table 7).

Thus the total cultivated crops constitute 55,914 acres, or 20.1 per cent of the county, 22.4 per cent being on A_1 division; 12.3 per cent on E_1;

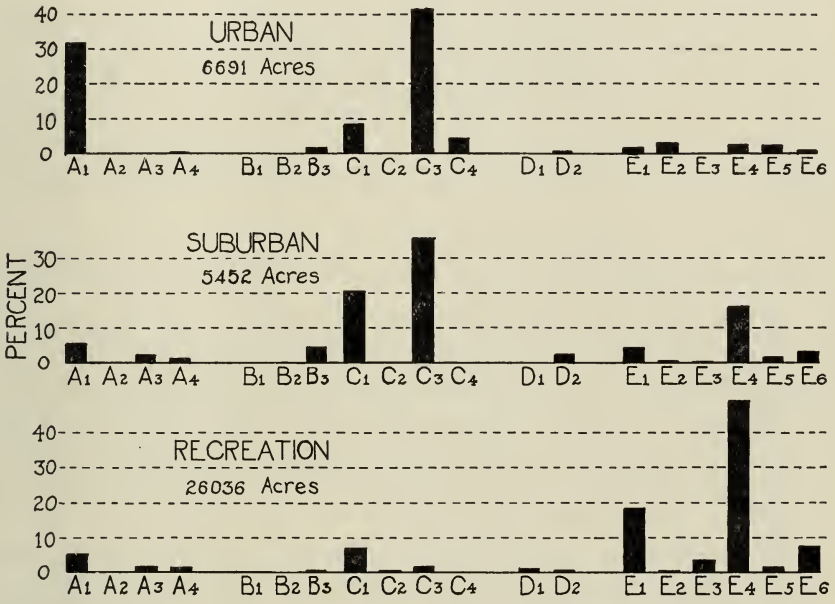


Fig. 26.—Distribution of land in the urban, suburban, and recreational-use classification on the natural land divisions.

12.1 per cent on C_3; and 10.8 per cent on C_1. On the basis of percentage cultivated, 100.0 per cent of B_2 is cultivated; 90.9 per cent of B_1; 86.9 per cent of C_2; 76.0 per cent of C_4; 73.0 per cent of A_2; 62.0 per cent of A_1; 59.8 per cent of D_1; 52.1 per cent of D_2; 50.6 per cent of C_1; 45.7 per cent of C_3; and the rest in much smaller proportion (fig. 24).

Grass constitutes 22,348 acres, or 8.0 per cent of the county and is fairly well scattered in small areas over many of the natural land divisions (fig. 25). For example, 38.0 per cent of E_2, and 19.2 per cent of D_2 are in grass, these being natural grassland types.

Timber constitutes 86,635 acres, or 31.1 per cent of the county (table 8). A large proportion consists of redwood and Douglas fir. By including the redwood and Douglas fir areas classed as "recreation" (fig. 26) there

was actually mapped 92,170 acres of redwood and Douglas fir in the Forest Service vegetation-type survey of 1935 and 1936.[6] Over 95 per cent of the timber occurs on the upland divisions E_1 to E_6). Small areas of ponderosa pine occur on the A_3 and E_3 divisions.

Woodland comprises 40,815 acres, or 14.6 per cent of the county. The principal species of the woodland type are tanbark oak, live oak, and madrone. Over 92 per cent of the woodland type occurs on the upland divisions, principally E_1, E_4, and E_6.

Brush includes principally toyon berry, manzanita, wild lilac, scrub oak, and mountain mahogany. It comprises 34,509 acres, or 12.4 per cent of the county (table 8). Brush generally occurs on the shallower and poorer soils; 42.2 per cent being on division E_6 and 34.8 per cent on E_4 (table 7). Land division E_6, which has stony shallow soils, has 36.0 per cent of its area covered with brush; while E_5, also shallow, has 22.6 per cent.

RELATION BETWEEN SOIL RATING AND PRODUCTIVITY

The Storie index rating for each individual soil type and the range in the soil rating (table 9) were calculated after the completion of the soil survey in 1935. The rating is based on the study of three general factors: the character of the soil profile; texture; and other modifying influences. Index numbers are used for each group of factors with 100 per cent expressing ideal conditions. The Storie index is the product of the ratings given each of these three factors.

All the soils of A_1 land division rate high on the basis of the natural soil characteristics with a range between 77 and 95 per cent according to the Storie index. A majority of the soils have a rating of either 90 or 95 per cent; and in table 9 the crop productivity ratings as set up on a county-wide basis have a rating of 90 to 100 per cent. This shows the close relation between soil rating and productivity.

The sandy soils of the A_2 division have a range in the Storie index rating of between 42 and 54 per cent. Their crop productivity rating varies between 40 and 70 per cent.

The sandy leached soils of division A_3, with a Storie index rating of 20 to 40 per cent, have a crop productivity rating varying between 20 and 50 per cent.

The soils of A_4 division are nonagricultural in character. They have a Storie index rating of 3 to 6 per cent. No crop productivity ratings are indicated because of their nonagricultural character.

[6] Jensen, Herbert A. Vegetation types and forest conditions of Santa Cruz Mountains unit. Forest Service Release No. 1. May 1, 1939. (Mimeo.)

TABLE 9

PRODUCTIVITY AND STORIE INDEX SOIL RATINGS COVERING THE NATURAL LAND DIVISIONS OF SANTA CRUZ COUNTY, CALIFORNIA

Natural land divisions	Storie index soil rating	Productivity ratings*											
		Barley (grain)	Beans	Hay	Sugar beets (irrigated)	Alfalfa (irrigated)	Artichokes (irrigated)	Berries (irrigated)	Lettuce (irrigated)	Apples	Grazing	Timber and woodland	Physical problems
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
A_1	77–95	100	100	100	90	90	100	100	100	100	90	E	.....
A_2	42–54	50	60	60	40	40	50	70	60	50	40	G	Sandy soils
A_3	20–40	30	30	30	—	30	40	50	30	20	20	F	Sandy, leached soils; low nutrient level
A_4	3–6	—†	—	—	—	—	—	—	—	—	—	P	Very sandy or stony
B_1	66–76	80	90	100	100	60	70	70	90	60	80	—	Clay soils, drainage
B_2	50–80	80	80	90	80	50	50	60	80	—	70	—	Drainage, subsidence
B_3	3–7	—	—	—	—	—	—	—	—	—	20	—	Salt, drainage
C_1	40–76	70	70	70	40	50	80	90	60	40	70	P	Fairly dense subsoils
C_2	42–54	50	50	50	—	30	60	80	50	—	30	P	Sandy leached soils, low nutrient level
C_3	38–51	40	60	60	30	30	70	70	50	20	70	—	Dense clay subsoils
C_4	42	70	80	80	50	40	60	70	60	40	90	—	Clay soils
D_1	17–42	20	40	30	—	30	—	50	30	20	30	F	Sandy, acid, very erosive; low nutrient level
D_2	31–32	40	50	40	—	30	50	60	40	20	70	P	Dense clay subsoils, erosive
E_1	30–63	50	40	50	—	30	—	60	—	30	60	E	Erosion, soil depth, slope
E_2	32	60	40	50	—	30	—	50	—	15	80	G	Slope, erosion, soil depth
E_3	10–20	—	—	—	—	—	—	30	—	—	20	F	Erosion, slope, sandy; low nutrient level
E_4	10–18	—	—	—	—	—	—	—	—	—	50	E	Slope
E_5	7–13	—	—	—	—	—	—	—	—	—	40	G	Soil depth, slope
E_6	2–4	—	—	—	—	—	—	—	—	—	20	G to P	Slope, soil depth, stoniness

* For crops, yields per acre assumed as standards of 100 per cent are:
Cols. 2 and 3: 15 sacks
Col. 4: 1.7 tons
Col. 5: 20 tons
Col. 6: 6 tons
Col. 7: 150 boxes
Col. 8: 125 chests
Col. 9: 250 packed crates
Col. 10: 1,000 boxes
For grazing (col. 11), carrying capacity for 100 per cent rating assumed as 0.8 acres per animal month.
For timber and woodland (col. 12), E, excellent; G, good; F, fair; P, poor.
† Dashes indicate no crop productivity ratings were made.

The heavy-textured soils of B_1 division, with a Storie index rating of 66 to 76 per cent, have crop productivity ratings of 60 up to 100 per cent for hay and sugar beets. They are not adapted to timber production.

The peat and muck soils of division B_2 have a fairly high productivity rating for field and truck crops when drained. They are not adapted to tree crops. The Storie index rating varies between 50 and 80 per cent. This range is due to the variable drainage factor.

The very poorly drained soils of division B_3 are not adapted to agricultural pursuits except occasionally a little pasture, therefore crop productivity ratings are not indicated in table 9. The Storie index rating is between 3 and 7 per cent.

The low terrace soils having fairly dense subsoils (C_1) have crop productivity ratings ranging between 40 and 90 per cent. The productivity rating for strawberries is 90 per cent. The Storie index ratings are between 40 and 76 per cent.

The sandy soils of the C_2 division, with a Storie index rating of between 42 and 54 per cent, generally have a productivity rating of about 50 per cent for most field crops, but for grasses it is lower.

The medium-textured claypan soils (C_3) having a range in Storie index rating of 38 to 51 per cent, rate low for deep-rooted crops and between 50 to 60 per cent for many of the field and truck crops. The adobe clay soils (C_4) have a fairly wide range in their productivity ratings. They rate high for grass and forage crops, but low for fruits.

The sandy high terrace soils (D_1) having a Storie index rating of from 17 to 42 per cent, generally rate low for field and truck crops. For berries and timber they rate higher. The medium-textured claypan soils of Division D_2, having a Storie index rating of between 31 and 32 per cent, rate moderately high for grass and berries but low for deep-rooted crops.

The medium-textured soils of the upland of moderate depth to bedrock (E_1) and occurring on the smoother surfaces have Storie index ratings ranging from 30 to 63 per cent. A majority of the crops rate between 40 and 50 per cent. For field crops they have a productivity rating of usually between 40 and 50. A productivity rating for sugar beets, artichokes and Brussels sprouts, and lettuce is not given because the soils are not adapted to culture for these crops. They have a good rating for grass and a high rating for timber.

The dark-colored soils of the Santa Lucia series (E_2) have a crop rating of 80 for grass and a rating of 60 for barley. Their productivity rating for other crops is lower. Their Storie index rating is 32 per cent.

The light-gray, sandy, leached soils of the Arnold series (E_3) have a Storie index rating of 10 to 20 per cent. They have a fair productivity

TABLE 10

Apple Production by Soil Types and Natural Land Divisions, Santa Cruz County, California

Natural land divisions and soil type	Age of trees	Number of records	Average production						Average production of all records
			1931	1932	1934	1935	1936	1937	
			boxes per acre	*boxes per acre*	*boxes per acre*	*boxes per acre*	*boxes per acre*	*boxes per acre*	*boxes per acre*
A_1:									
Soquel loam	20–30	8	.....	.....	806	775	865	1,163	1,088
	28	2	1,394	1,998	...	.....	...	.....	
	31	8	1,077	1,170	...	.....	...	.....	
	33	1	1,437	.....	...	.....	...	.....	
	41	2	1,367	1,307	...	.....	...	.....	
Soquel sandy loam	20–30	1	.....	.....	...	.....	536	.....	
Soquel clay loam	20–30	1	.....	.....	...	.....	576	.....	
Botella clay loam	20–30	5	.....	.....	...	1,238	977	2,420	
Botella silty clay loam	20–30	3	.....	.....	...	983	...	.....	
	31	1	1,091	.....	...	.....	...	.....	
Pajaro clay loam	20–30	2	.....	.....	...	700	...	.....	
A_2:									
Corralitos sand	19	2	455	817	...	.....	...	.....	410
	20–30	12	.....	.....	345	317	332	447	
	38	2	495	484	...	.....	...	.....	
C_1:									
Pinto loam	20–30	15	.....	.....	312	404	429	320	379
C_3:									
Watsonville loam	17	1	.....	.....	...	20	...	.....	142
	20	4	.....	.....	...	167	...	.....	
	20–30	1	.....	.....	...	213	...	.....	
Watsonville clay loam	20–30	3	.....	.....	70	135	175	.....	
D_1:									
Moro Cojo loamy sand	12	2	.....	.....	...	63	...	.....	172
	20	8	.....	.....	...	.....	165	234	
Moro Cojo sandy loam	12	3	.....	.....	...	152	...	.....	
	17	1	.....	.....	...	250	...	.....	
	20	3	.....	.....	...	159	...	.....	
	29	2	156	262	...	.....	...	.....	
	31	2	297	271	...	.....	...	.....	
	33	2	112	168	...	.....	...	.....	
D_2:									
Tierra clay loam	20	2	.....	.....	196	338	...	.....	267
E_1:									
Hugo loam	29	1	365	.....	...	.....	...	.....	271
	31	6	786	439	94	149	125	55	
Hugo sandy loam	20	2	610	400	...	.....	...	.....	
	20–30	7	.....	.....	...	.....	255	192	
Cayucos sandy loam	20–30	1	.....	.....	...	.....	...	231	
Cayucos loam	20–30	2	.....	.....	161	150	...	.....	
E_2:									
Santa Lucia clay loam	20–30	2	.....	.....	...	98	...	153	126

rating for timber, but a low rating for grazing and berries. Productivity rating for other crops is not given because these are not grown.

Owing to steep slopes, the upland division E_4 (Storie index rating of 10 to 18 per cent) is not adapted to any tilled crops. The soils of this division are given a productivity rating of 50 for grazing. The rating for timber is high. Upland division E_5 has fairly shallow soils on slopes that

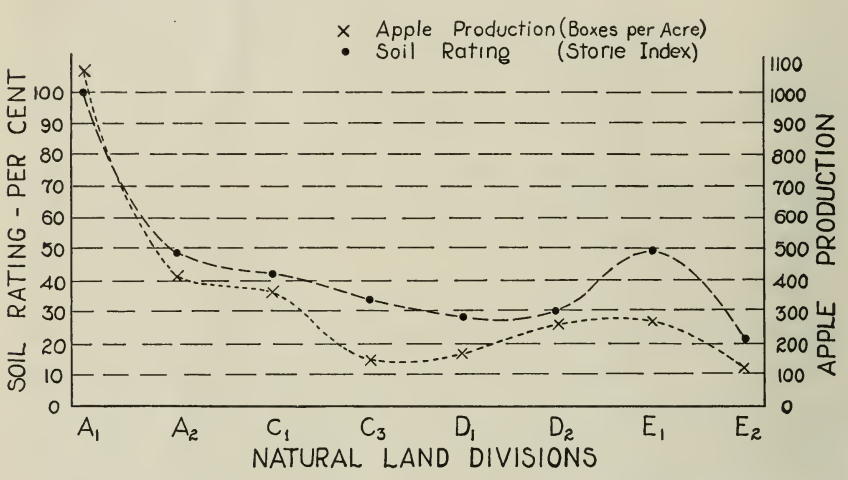


Fig. 27.—Correlation between soil ratings and apple yields by natural land divisions in Santa Cruz County.

are not adapted to tilled crops. These soils have a Storie index rating of 7 to 13 per cent. Productivity rating for grass is given as 40. The rating for timber is good.

The steep upland with very shallow stony soils has a very low Storie index rating (2 to 4 per cent). These soils are of nonagricultural character. Their rating for timber is variable, ranging from good to poor, owing to the variable character of the soils.

Correlation between Soil Rating and Apple Yields.—Figure 27 shows the correlation between apple yields expressed in boxes per acre and the character of the soil, as expressed by the Storie index rating. The actual production of apples is, of course, the result of soil, climate, and management factors, whereas the Storie index rating considers a rating of the soil factor or the potential physical productivity of soil after a study of soil texture, depth, nutrient properties, alkali content, reaction, drainage, slope, erosion, etc. Yet it will be noted that the apple production and soil-rating curves follow each other very closely. This brings out the fact that soil properties are of dominant importance in determining productivity of land for apples, particularly in Santa Cruz County.

Fig. 28.—*A*, Apple orchard on Soquel loam, a deep, medium-textured, recent alluvial soil (A_1); average annual yield is over 1,000 boxes per acre. *B*, Apple orchard on Pinto loam, a low terrace soil (C_1) having moderately dense subsoils; average annual yield is between 300 and 500 boxes per acre. (Pictures taken at a distance of 35 feet from first tree.)

Fig. 29.—*A*, Apple orchard on Watsonville loam, a low terrace soil having very dense clay subsoil (C_3); average annual yield is between 20 and 214 boxes per acre. *B*, Apple orchard on Tierra loam, a high coastal terrace soil having very dense subsoil (D_2); production is low, and several trees are missing. (Pictures taken at a distance of 35 feet from first tree.)

All the high-rating soils in division A_1 produce heavily, a majority of the orchards under study yielding between 1,000 and 1,300 boxes per acre (table 10); the intermediate-rating soils of division A_2 and C_1 show yields of generally between 200 and 500 boxes per acre; whereas the claypan soils (C_3), the Moro Cojo soils (D_1), the Tierra soils (D_2), and the upland soils (E_1 and E_2) generally have low yields. Figures 28 and 29 are excellent illustrations of the effect of soil on the size of trees. Apple yields on the deeper upland soils (E_1) are variable and depend to a considerable extent on such factors as depth of soil, slope, and erosion. No doubt proper management can help to keep the yields higher on these better grades of upland soils.

SUMMARY AND CONCLUSIONS

The unit of classification is termed the "natural land division" and delineates bodies of land having a uniformity or homogeneity of natural physical characteristics such as topography, soils, drainage, erosion, and climate—characteristics which also define the natural productivity of land for plant growth.

A standard set of symbols and colors have been used in this and other counties of California for this classification. The main physiographic groups such as smooth valley, basin, low terrace, high terrace, and upland are designated by the symbols A, B, C, D, and E. Natural land divisions are drawn up under each physiographic group in Santa Cruz County as follows: permeable valley soils as A_1, A_2, A_3, A_4, and shown by yellow colors; basin soils as B_1, B_2, B_3, and shown by green colors; low terrace soils as C_1, C_2, C_3, C_4, and shown by blue colors; high rolling terrace soils as D_1, D_2, and shown by purple colors; and upland soils as E_1, E_2, E_3, E_4, E_5, E_6, and shown by red colors.

The medium-textured, recent and young alluvial soils (A_1) are adapted to a wide range of crops with high yields. These soils have a high index rating. They make up only 7.2 per cent of the county, yet have 22.4 per cent of the cultivated crops and 24.5 per cent of the total orchard acreage. About 62 per cent of these soils are being used for cultivated crops.

The alluvial-fan soils of sandy texture (A_2) make up only 1.2 per cent of the county. About 66 per cent is being used for orchard purposes, primarily apples. Their productivity is only about half that of the A_1 division and the soil rating also is about 50 per cent.

The light-colored, alluvial-fan soils (Laguna loamy sand, A_3) generally are not adapted to crop use. They make up only 0.9 per cent of the county. A large proportion is in timber, woodland, or brush.

The heavy-textured soils (B_1) are of high productivity for field crops.

They make up only 0.4 per cent of the county, and over 84 per cent is being utilized for field crops.

Peat and muck soils (B_2) are of high productivity for field and truck crops.

The medium-textured, low terrace soils having moderately dense subsoils (C_1) constitute 4.3 per cent of the county. They are used for many field crops, about 50 per cent being cultivated. Berries, artichokes and Brussels sprouts, beans, and some of the other shallower-rooted crops do well, although the productivity is not so high as that of the A_1 division.

The sandy, low terrace soils of the Marina and Elkhorn series (C_2) are highly acid, leached, and of moderate to low productivity for field crops. They are not adapted to orchard use. Truck and field crops make up 83.4 per cent of this division. These soils constitute only 1.1 per cent of the county.

The claypan terrace soils (C_3) constitute 5.3 per cent of the county, with 32.0 per cent being used for urban and suburban purposes and 26.9 per cent for truck and field crops. About 42 per cent of the artichokes and Brussels sprouts are raised on these soils. In general these soils are not adapted to deep-rooted plants. They rate between 38 and 51 per cent.

The adobe clay terrace soils (C_4) are used primarily for field crops for which they appear well adapted, but they are not so well adapted to orchard or timber.

The sandy high coastal terrace soils (D_1) constitute 3.0 per cent of the county. About 44 per cent is used for orchard, principally apples; about 24 per cent is timber-woodland-brush complex. Their Storie index rating is from 17 to 42 per cent. They are very erosive.

The higher coastal-plain terrace soils having dense clay subsoils (D_2) are not extensive (1.0 per cent of county). Field crops, orchard, and grazing are about evenly divided on this type of land. Apple production is low; field crops produce moderately; and grass growth is good. These soils are very erosive unless covered by vegetation during the rainy season.

The smooth upland soils (E_1) of medium texture comprise about 12.5 per cent of the county, with about 19.7 per cent of the division being used for tilled crops. These soils are only moderately productive for tilled crops because of slope, erosion, and soil-depth factors. Growth of timber is excellent.

Of the darker-colored upland soils classed in the Santa Lucia series (E_2) 38.0 per cent is in grass. Their productivity for grass is relatively high but their productivity rating is lower for tilled crops. These soils comprise only about 0.8 per cent of the county.

The leached soils of the Arnold series (E_3) have a fair timber and good recreational-site value, but are not adapted to agricultural crops. They comprise only 0.7 per cent of the total area of the county.

The steep upland composed of medium-textured soils of good depth (E_4) constitute the extensive timberlands and make up 41.9 per cent of the area of the county. About 78 per cent is a timber-woodland-brush complex. Slopes are generally too steep for tilled crops.

The shallower and stonier upland area (E_5 and E_6) comprises about 18 per cent of the county and is typically in timber, woodland, or brush. Many of the areas of E_6 along the eastern edge of the county are brush-covered.

A close correlation exists between apple yields and the character of the soil as expressed by the Storie index ratings.

The soils in land divisions A_1, B_1, and B_2 are the best agricultural soils of the county, whereas those of divisions A_2, C_1, C_2, C_3, and C_4 are of agricultural character but are more erosive, as well as being of somewhat lower productivity. These types make up 57,000 acres, or 20.5 per cent of the county.

A considerable portion of divisions A_3, D_1, D_2, E_1, and E_2 have distinct slope and serious erosion problems. This group comprises 50,895 acres, or 18.2 per cent of the county.

Divisions E_3, E_4, E_5, and E_6 constitute timber, woodland, or brush land totaling 168,478 acres, or 60.5 per cent of the county.

Divisions A_4 and B_3 consist of riverwash, coastal beach, and dunesand and tidal land, totaling 2,027 acres, or 0.8 per cent of the county.

The type of land classification described in this publication appears to be a desirable means of accurately picturing the land setup and physical geography of an area, as well as being a type of land classification applicable for purposes of land-use study.

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